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Secţia VIII
TEXTILE. PIELĂRIE

LA DÉTERMINATION DU MODULE DYNAMIQUE DES FILS CONTINUS DE POLYVINYLALCOOL

PAR
CLEOPATRA OPREA et IRINA TĂRĂBOANŢĂ

Cette étude expérimentale concerne l'influence des ultrasons dans la relation structure – propriétés pour le fil filamentaire de type polyvinil alcoolique SOLVRON-SX qui a été sollicité sous differentes charges.

1. Introduction. On sait que le fil continu de type PVA-soluble dans l'eau, préparé par un processus d'obtention différent de ce du vynylon ordinaire, est de plus en plus utilisé dans l'industrie textile. En mélange avec les fils naturels (laine, coton), ce fil servt comme support et après la réalisation de l'article textile suivrment la dissolution du fil PVA dans l'eau chaude, résultement une structure „allégée" et très cherchée de créateurs de la mode vestimentaire [1].

Dans cet article on a suivi la détermination de la vitesse d'ultrason et du module d'ultrason du filament SOLVRON-SX de type PVA suomis à des sollicitations variables et puis à la relaxation par la méthode basée sur le principe de la propagation d'ondes ultrasons.

2. Partie Expérimentale. La méthode qui a été utilisé, est basée sur le principe de la propagation d'ondes ultrasons émises par un générateur d'ondes [2].

Le dispositif qui a été utilisé pour la obtention des ondes ultrasons est basé sur le phénomène piézo-électriques – „Dr. Steinkamp Ultrasonic Tester BP V".

Ainsi, le filament de PVA a été maintenu entre deux céramiques piézo-électriques de distances variables (on a choisi 12,5 cm et 17,5 cm).

On a suivi le comportement du filament SOLVRON-SX dans un champ ultrasonique soumis:

1 – *à des sollicitations variables*; le fil a été sollicité avec suivantes charges: 10 g, 20 g, 30 g, 50 g, 70 g, 90 g, 100 g, 120 g, et on sait que pour la même durée de sollicitation mais pour forces de sollicitation croissantes on constate une tendance de réduction de la capacité de retour elastique et d'augmentation de la déformation remanente. On a observé une augmentation du module d'ultrason pour forces de sollicitation croissantes.

2 – *à l'état de relaxation*; on a écarté la charge de sollicitation pour voir la différence entre le module d'ultrason obtenu en cas du fil sollicité et puis relaxé. On

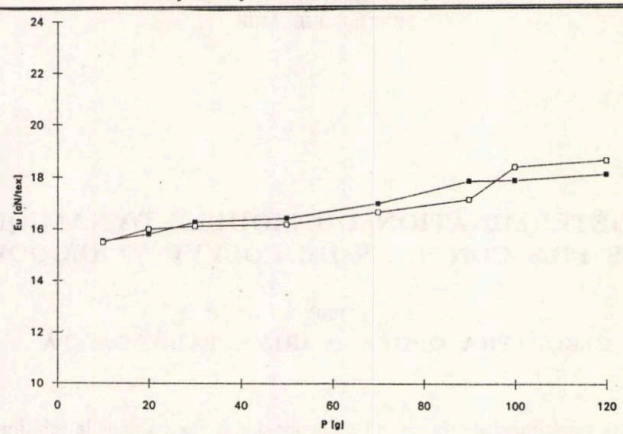

Fig. 1.– Le module d'ultrason du filament SOLVRON-SX pour forces de sollicitation croissantes. □ – aprés 30 s; ■ – instantané.

note des valeurs du module d'ultrason plus faibles par rapport à celle obtenues par sollicitations du filament.

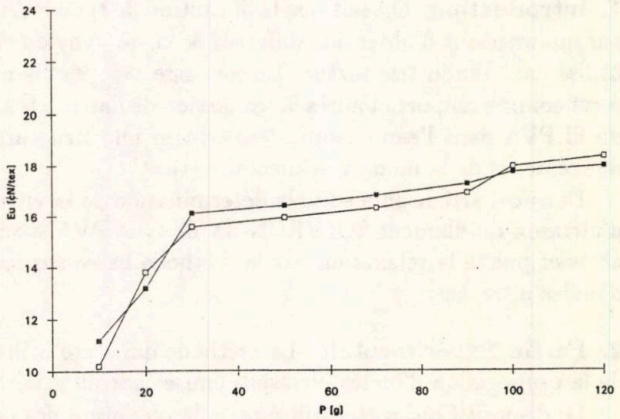

Fig. 2.– Le module d'ultrason du filament SOLVRON-SX à l'état de relaxation. □ – aprés 30 s; ■ – instantané.

3 – *à l'état humidé*; après relaxation, le fil a été immersé dans l'acetone et puis soumis des sollicitations dans champ ultrason; parce que le fil est soluble dans l'eau, on a choisi comme milieu d'immersion l'acétone car on sait que l'ondes ultrasons se propagent mieux dans milieu humide, dans milieu sec existement une atténuation à elles. On a observé une augmentation du module d'ultrason pour forces de sollicitation croissantes.

Pour chacun cas on a noté le temps d'ultrason instantané et aprés 30 secondes affiché sur l'ecran du générateur d'ondes.

Le calcul du module d'ultrason a été realisé connaîtrement la longueur du filament entre ces deux pinces ceramiques piézo-électriques et le temps d'ultrason affiché [3]:

$$E_u = \rho \cdot v_u^2$$

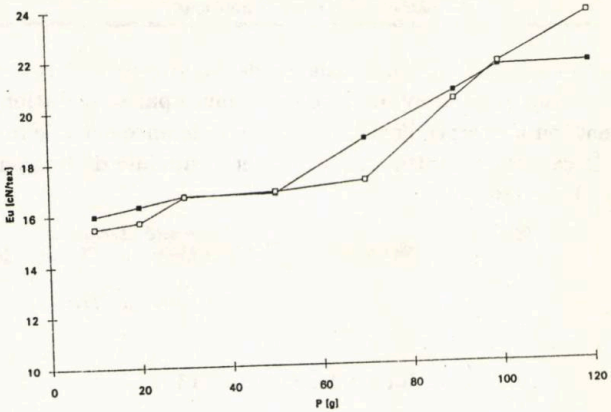

Fig. 3.– Le module d'ultrason du filament SOLVRON-SX à l'état humidé. □ – aprés 30 s; ■ – instantanée.

où: E_u – le module dynamique, [N/tex]; v_u – la vitesse de propagation d'ondes ultrason, [m/s]; ρ – la densité, [g/cm^3].

3. Résultats et Discussions. Après la réalisation d'un très grand nombre d'expériments pour la détermination de la vitesse d'ultrason, donc du module d'ultrason du filament SOLVRON-SX, on a observé les aspects suivants:

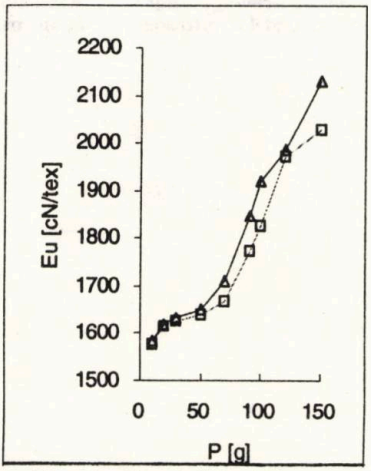

Fig. 4.– Le module d'ultrason du filament SOLVRON-SX. △ – après 30 s; □ – instantané.

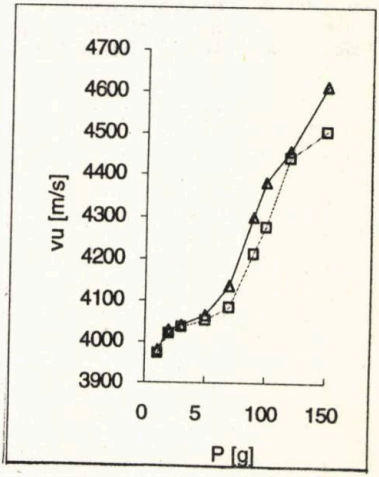

Fig. 5.– La vitesse d'ultrason du filament SOLVRON-SX. △ – après 30 s; □ – instantané.

– une augmentation de la solicitation entraîne une augmentation de la vitesse d'ultrason;

– une augmentation de la vitesse d'ultrason entraîne une augmentation du module d'ultrason;

– à l'état relaxé, on note des valeurs de la vitesse d'ultrason et du module d'ultrason, plus faibles par rapport à celle obtenues par sollicitations du filament;

– également, on a observé l'existence d'une difference entre le module d'ultrason obtenu dans le cas des échantillons normals et le module d'ultrason obtenu dans le cas des échantillons fatigués.

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Université Technique „Gh. Asachi", Jassy,
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et
Chaire de Tricotajes et Confections

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DETERMINAREA MODULULUI DINAMIC AL FIRULUI FILAMENTAR DE TIP POLIALCOOLVINILIC

(Rezumat)

S-a urmărit studiul experimental şi analitic al modulului dinamic pentru firul filamentar de tip polialcoolvinilic SOLVRON-SX şi modificările care apar în relaţia structură–proprietăţi la solicitarea firului cu diverse sarcini de solicitare, în prezenţa acţionării undelor ultrasonore atât în mediu atmosferic standard, cât şi în mediu lichid.

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Secţia VIII
TEXTILE. PIELĂRIE

WOOL'S GRAFTING THROUGH INITIATION WITH UV RADIATIONS

XI. TOPOCHEMISTRY AND MECHANISM OF THE REACTIONS OF WOOL'S GRAFTING WITH ALKYL AND HYDROXYALKYL ACRYLATED-TYPE MONOMERS

BY

V. BLAŞCU and AURELIA GRIGORIU

The grafting phenomenon is quite complex, involving several factors of influence, related both to the fiber's structure and to the monomer's reactivity, its diffusion, as well as to the conditions of the reaction's initiation, propragation and interruption.

The physico-chemical, mechano-rheological, thermal and structural analyses performed on the grafted wool samples, and presented earlier, support the proposed mechanism, of UV grafting with alkyl and hydroxyalkyl acrylated-type monomers.

The same results permit putting forward of some hypotheses on the process' topochemistry.

A special importance in the study of wool fibers' grafting is given to the establishment of the place where the active centers and the increase of the macromolecular chain occur, where the grafted polymer is deposited, the place of the termination reaction mechanism, i.e. the topochemistry of wool's grafting reaction.

Initially, it was considered that the deposition of the grafted polymer occurs only on the fiber's surface but, in time, it was observed that grafting is also developed inside the fiber. Along the years several hypotheses have been put forward as to the place where the macromolecular chains increases on grafting.

The polymer's distribution in the fiber's section has been examined from a kinetic point of view, too [1]. Optical microscopic photos have been taken through contrasting with Celliton Fast Blue B, which permitted the analysis of the bilateral structure and also the fact that the grafting polymer is preponderently distributed in the orthocortex, known as having a higher content of crystalline microfibrils, and a lower "concentration" of the –S–S– crosslinks, comparatively with the paracortex.

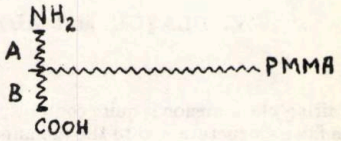
The formation rate of the grafting active centers has been followed in various grafting systems, the influences of the various kinetic factors being studied [2]. If the rate of grafting and formation of the active centers is lower, a more uniform distribution of the polymer in the fiber's section will be obtained.

As early as 1949, F.H. M e r c e r investigated the polymer's localization in the wool fiber grafted with methacrylic acid, and suggested its deposition in the fiber's extrafibrillar regions, as well as in the intercellular ones [3].

Later on, based on modern techniques of investigation, i.e. electronic microscopy (SEM) and RX difraction, several authors [4], [5] studied the localization of various polymers grafted through initiation with γ radiations, thus postulating the idea of the grafts' localization in the matriceal region between the microfibrils.

The observation was made that, through grafting, a series of properties of the wool fiber are modified, a situation which cannot be explained only by the hypothesis of surface grafting. For example, the dye absorption is characterized by a higher diffusion rate of the grafted wool, as a result of the fiber's swelling through grafting and partial destruction of the crystalline structure [6].

In most cases, the polymers are grafted on polypeptidic chains in the form of branches. For example, in the case of methyl methacrylate (MMA) grafting, the following structure was proposed [7]:



The mechanism of grafting's formation is the "pop-corn" type.

The quantitative determinations of the aminoacidic terminations in the copolymer chains grafted with 2,4-dinitrofluorbenzen (FDNB) led to the conclusion that the following mechanisms of growth termination of the grafted polymer's macromolecular chain may occur [8], [9]:

- recombination and disproportionation of the grafted copolymer's macroradicals;
- chain transfer of the macroradical of the copolymer grafted to thiol groups;
- termination through the reaction between the macroradicals of the grafted copolymer and the primary radicals of either wool or the formed homopolymer.

For example, increase, through grafting, of wool's mechanical indices is a result of the pronounced tendency of termination of the chain's growth through recombination of the growing macroradicals with other macroradicals or thiol radicals from the neighbouring chain (i.e., crosslinked), while disproportionation or chain transfer (i.e., additional branches) affects the mechanical behaviour of the grafted fibers, comparatively with the reference ones.

Formation of the active centers on the fiber drew special attention from the specialists' part.

On following the mechanism of methyl methacrylate grafting, initiated in an aqueous system with LiBr-$K_2S_2O_8$, known as inducing no homopolymer formation, it was observed that the thiolic groups generate centers for grafting [10]. The rate of the grafting reaction and the grafted polymer's average degree of polymerization ($\overline{GP}$) provide information on grafting's topochemistry.

Also, it is generaly known that reduction of the cystinic bonds facilitates grafting of the vinylic monomers [2], [11].

By comparing the electronic microscopy images of the grafted and, respectively, reference fibers, the observation was made that, morphologically, the fibers grafted with MMA through redox initiation are not apparently different from the normal

ones, even at high grafting degrees, most of the grafted polymer being localized in the matrix, for example among microfibrils [11]. Modifications in the fiber's structure may be observed as a function of the applied treatment. In treatments with Na_2S, a more pronounced laying of the polymer on the scales' surface, and especially between scales, is observed. Modifications appear in cross section, especially in the cortical region, due to the generation of thiolic groups, rich in cystinic bonds, mainly in the paracortex and in the matrix, while the matrix's suprastructure permits the reactants' diffusion.

The grafting phenomenon is quite complex, involving several factors of influence, related both to the fiber's structure and to the monomer's reactivity, its diffusion, as well as to the conditions of the reaction's initiation, propagation and interruption.

Another difficult problem refers to the localization of the free radicals formed in the fiber through various techniques of grafting's initiation, such as: chemical (redox, etc.), physical (X, γ, UV) or combined. To this end, the techniques of spin electronic resonance (RES) are applied, involving comparison of the hyperfine structure of both unmodified and modified wool's RES spectra. It was observed that, besides the cistyl ones, tyrosyl or triptophyl radicals may be also formed, which means that the initiation of grafting involves, too, participation of other aminoacids from wool [12], [13].

Another factor influencing the topochemistry of wool fibers' grafting is the utilization of solvents or of other substances that "open" the fiber's histomorphological structure, thus favourizing the reaction [14].

Based on the experimental results we obtained in wool's grafting through UV radiations initiation with alkyl and hydroxyalkyl acrylated type monomers [15], [16], as well as on the grafted fibers' complex characterization [17],...,[28], some hypotheses on the process's mechanism and topochemistry will be discussed in the following.

Wool possesses multiple functional groups (–NH_2, –COOH, –OH, –SH, etc.) as well as a cystinic bond (–S–S–), which may be activated through UV iradiation, for the generation of the active centers that will initiate the monomer's grafting. Initiation being developed in a heterogeneous medium, including wool fibers (WH), monomer (M), solvent (SolH) (benzen, dimethyl formamide, dioxane), photosensibilizer (FS), superphotosensibilizer (SFS), traces of water (H_2O), the action of the UV radiation ($h\nu$) will activate all this small molecules and keratine's macromolecule (WH), too, finally generating radicals:

$$S + SFS \xrightarrow{h\nu} (S + SFS)^*$$

$$WH \xrightarrow{(S+SFS)^*} WH^* \longrightarrow W\cdot + H\cdot \qquad WH^* - \text{activated state}$$

$$SolH \xrightarrow{(S+SFS)^*} SolH^* \longrightarrow Sol\cdot + H\cdot$$

$$H_2O \xrightarrow{(S+SFS)^*} H_2O^* \longrightarrow H\cdot + HO\cdot$$

$$M \xrightarrow{(S+SFS)^*} M^* \longrightarrow M\cdot$$

Denoting the formed radicals by R·, initiation of the grafting process may occur

as follows:

$$R\cdot + M \longrightarrow RM\cdot$$
$$W\cdot + M \longrightarrow WM\cdot$$

There follow the propagation reactions:

$$RM\cdot + nM \longrightarrow R\text{-}(M)\text{-}_{n+1}\cdot$$
$$WM\cdot + nM \longrightarrow W\text{-}(M)\text{-}_{n+1}\cdot$$

The reactions for the interruption of the macromolecular chain's growing would be:

$$W\cdot + \cdot\text{-}(M)\text{-}_{n+1}R \longrightarrow W\text{-}(M)\text{-}_{n+1}R$$

graft

$$W\text{-}(M)\text{-}_{n+1}\cdot + \cdot\text{-}(M)\text{-}_{n+1}R \longrightarrow W\text{-}(M)\text{-}_{2n+2}R$$

graft

$$R\text{-}(M)\text{-}_{n+1}\cdot + \cdot\text{-}(M)\text{-}_{n+1}R \longrightarrow R\text{-}(M)\text{-}_{2n+2}R$$

homopolymer

Scission of the cystinic bond, through UV activation:

$$> CH - CH_2 - S - S - CH_2 - CH < \xrightarrow{(S+SFS)^*} > CH - CH_2 - S^* - S^* - CH_2 - CH < \longrightarrow$$
$$\longrightarrow 2 > CH - CH_2 - S\cdot$$
$$> CH - CH_2 - S\cdot + nM \longrightarrow > CH - CH_2 - S\text{-}(M)\text{-}_n\cdot$$

or the R· radical's attack to the cystinic bond:

$$> CH - CH_2 - S - S - CH_2 - CH < + R\cdot \longrightarrow > CH - CH_2 - S - R\cdot + \cdot S - CH_2 - CH <$$

are also possible.

The reaction being developed in air, in the beginning, O_2 may act either as an inhibitor or as a "retarder", while further on, after formation of the oxygen radical O·, it acts as an accelerator, as observed by other authors [29].

The modifications of the UV irradiated wool fibers, at molecular level, have been evidenced by some authors through RES analyses, aminoacids dosings and elementary analysis too [30]. An increase of the RES signal with the exposure time was observed, meaning the occurrence of the cystil radicals through homolytical scission of the dissulphuric and, respectively, tyrosyl link.

The aminoacids' analysis [30] evidenced that wool's UV irradiation induced certain modifications, i.e., additional crosslink, accompanied by the occurence of the new lysino-alanine and methionine-sulfoxide-type links, by an oxidative process (induced by the O_2 from the air). The phenomenon becomes strong when the irradiation is increased.

The physico-chemical [17], [18], mechano-rheological [19], [20], thermal [23] and structural [21], [24] analyses performed on the grafted wool samples support the proposed mechanism, of UV initiated grafting with alkyl and hydroxyalkyl acrylated-type monomers.

The same results permit putting forward of some hypotheses on the process' topochemistry.

The electronic microscopic images evidence, in a first stage, the fiber's superficial grafting, which attenuates the fiber's scaly aspect.

Improvement of the mechano-rheological, tinctorial (in the case of grafting with hydroxyalkyl acrylates) indices, and of the thermal behaviour through grafting, alongwith the aspect of the fractures obtained, permit the observation that the grafting reaction occurs inside the fiber, too, preponderently in the matriceal region. The monomer's access inside the fiber is favourized by swelling actions induced by the applied organic solvent.

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GREFAREA LÂNII PRIN INIŢIERE CU RADIAŢII UV
XI. Topochimia şi mecanismul reacţiilor de grefare ale lânii cu monomeri de tip alchil şi hidroxialchil acrilaţi

(Rezumat)

Fenomenul grefării lânii este complex, mulţi factori de influenţa concură, atât cei legaţi de structura fibrei, cât şi de reactivitatea monomerului, de difuzia acestuia, de condiţiile iniţierii, propagării şi întreruperii reacţiei.

Analizele fizico-chimice, mecano-reologice, termice, precum şi cele structurale efectuate asupra probelor de lână grefate şi prezentate în cele 10 lucrări anterioare argumentează mecanismul propus de grefare iniţiată UV, cu monomeri alchil şi hidroxialchil acrilaţi.

Aceleaşi rezultate ne permit să emitem ipoteze asupra topochimiei procesului.

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Secţia VIII
TEXTILE. PIELĂRIE

POSSIBILITIES OF EXTENDING THE SPINNING LIMITS IN THE PRODUCTION OF FINER ROTOR YARNS

BY

DEMETRA L. BORDEIANU and M. CIOCOIU

Dans le présent travail les auteurs ont essayé de mettre en évidence certaines caractéristiques des fils OE peignés en comparaison avec les fils OE cardés.

L'emploi d'une préparation de type peignage détermine la croissance de la limite de filabilité jusqu'à Nm 100 et donc de faire, un pas de plus, vers la production économique de filés rotor fins de qualité.

1. Introduction. The present work deals with the influence of the combing process upon the yarns quality and upon the possibilities of extending the spinning limit to finer rotor yarns.

Trash content and high percentage of short fibre impose limits on yarn count. A satisfactory strength yarn can be obtained only from very strong fibres.

The results showed the possibility of obtaining yarns with a higher tensional quality and extending yarn count range by using combed cotton.

2. Tested Variants. In order to emphasize the interdependence factors such as: raw materials, preparation methods, that is sliver quality, and the OE yarn quality, cotton imported from Ex-Soviet Union was used.

The main characteristics of the fibres used in the research are presented in Table 1.

Table 1

Characteristics		Cotton grades superior
Fibre linear density	mtex	129.13
Fibre fineness	Nm	7.744
Staple length	mm	37.8
Short fibres	%	13.52
Strength	cN/fibres	3.55
Tenacity	cN/tex	27.51
Trash	%	2.94

The following variants of feed sliver was supplied at the rotor spinning machine:

- carded sliver;
- combed sliver with 10% level of noil;
- combed sliver with 15% level of noil;

– combed sliver with 20% level of noil.

In order to reduce, as much as possible, the factors which influence the yarns tenacity, a series of measures were adopted during the experiment. Thus the following results were achieved:

– the maintaing of some lots of fibres;

– experimental tests under the same microclimate conditions;

– the use of identical spinning conditions that is: rotor speed 40,000 rot/min and openning roller speed 7,500 rot/min.

Nm 50 cotton yarns from Nm 0.28 fineness sliver and Nm 70, 80, 85 and 90 from Nm 0.4 fineness sliver in the variants presented in Fig.1 were spun on the BD 200 RN machine.

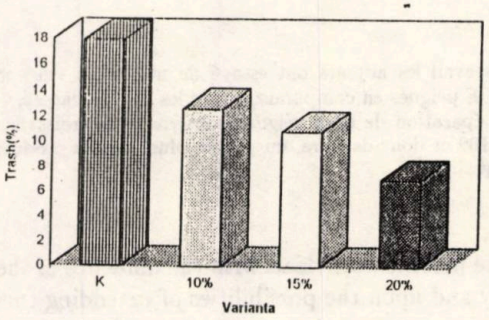

Fig. 1.– Trash content in cotton slivers.

3. Results. The advantage of using slivers with a low trash content in rotor spinning is well-known, the most important thing is a lower deposit content in rotor groove having implications upon the yarns quality, but also the spinning conditions by reducing the thread breaks per 1,000 rotor hours.

Fig. 1 shows the trash content in the sliver with increasing noil removal. A noil removal as low as 10% to 20% was able to reduce the trash content in the sliver from 70.58% to 47.06% of the carded lap.

The tensional characteristics of the resulting yarns were established on the MESDAN Strength Tester dynamometer.

Fig. 2 graphically shows the increasing in percentage of the OE combed cotton yarns tenacity in comparison with that of the OE carded cotton yarns. Noil removal rates of 15% are optimum for the variants investigated. From noil removal rates an increase of the yarn tenacity with 13.51% can be observed.

The increasing of the yarns tenacity by processing the combed sliver is significant (about 10%) and reproductible for the variants that were used, being possible to be mentained for other cotton types.

Under these circumstances we can presume the possibility of generalising the use of combed cotton to obtain a higher quality of the OE yarns.

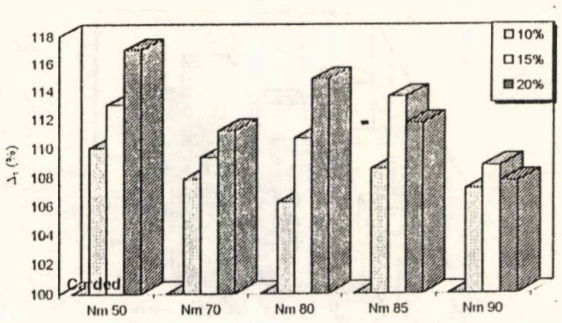

Fig. 2.– Increase of yarns tenacity of combed rotor yarns as compared to carded ones.

The average elongations at break of the tested yarns represented graphically in Fig. 3 show an insignificant increasing of these feature characteristics as a consequence of the combing process.

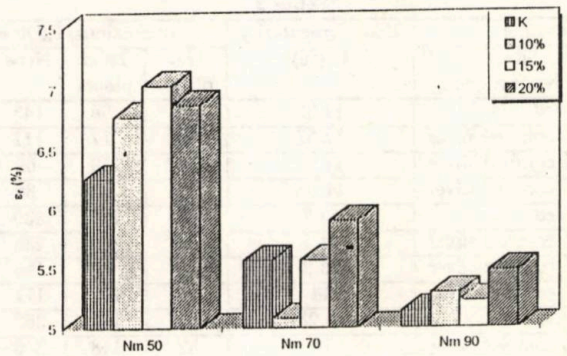

Fig. 3.– Elongation of OE carded and combed yarns.

For the variants with noil removal rates of 20% were found:

– the decreasing of short fibres percentage with 63.26%;

– the decreasing of neps frequency in the supplied sliver with 21.17%;

– the decreasing of trash content in the supplied sliver at the rotor spinning machine with 47.06%.

These would lead to the decreasing of the deposits into the rotor groove and of the trash remained in the yarn, thus resulting more resistant and uniform yarns.

Fig. 4 reveals the influence of sliver preparation upon the irregularity of yarn breaking reflected by the variation coefficient of this one.

Groove contamination continues to be a primary problem in rotor spinning, that is why all precautions have to be taken in order to avoid deposits. The trash content

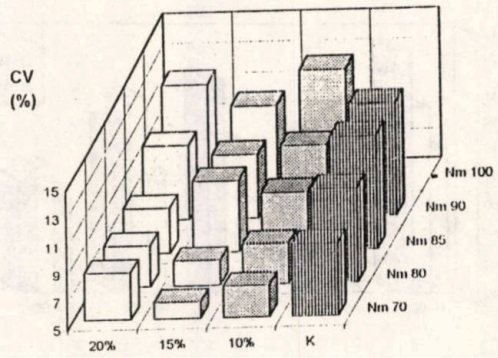

Fig. 4.– Iregularity of yarn breaking.

in the feed sliver having also implication upon the irregularities of the OE yarns, thus causing yarn hairness and increase the frequence of imperfection per 1,000 m yarn.

Table 2

Variants		Uster irregularity U (%)	Imperfections/1,000 m yarn			
Nm	Sliver preparations		Thin places	Thick places	Neps	Total
50	Carded	14.03	56	89	143	288
	10% combed sliver	12.57	24	72	111	207
	15% combed sliver	11.78	18	39	69	126
	20% combed sliver	11.93	39	42	85	166
70	Carded	14.9	64	144	330	538
	10% combed sliver	14.1	34	139	238	411
	15% combed sliver	13.2	16	71	165	252
	20% combed sliver	14	21	102	171	294
80	Carded	15.28	69	185	362	616
	10% combed sliver	15	52	148	326	526
	15% combed sliver	14.2	35	131	304	470
	20% combed sliver	14	31	96	223	350
85	Carded	15	52	148	226	426
	10% combed sliver	14.9	35	151	204	390
	15% combed sliver	14.2	31	96	223	350
	20% combed sliver	14.4	29	135	162	326
90	Carded	15.8	41	106	239	386
	10% combed sliver	14.8	55	97	238	390
	15% combed sliver	13.9	18	94	179	291
	20% combed sliver	14.8	17	83	199	299
100	Carded	–	–	–	–	–
	10% combed sliver	15	49	130	225	404
	15% combed sliver	14.5	5	152	167	324
	20% combed sliver	14.8	26	129	169	324

In Table 2 there are presented the values of the Uster irregularity and the frequence of imperfections (thin places, thick places and neps) of cotton types taken into study.

As a consequence of the combing process for the yarns obtained, there also appears a decreasing of the faults per 1,000 m yarn measured on Uster Tester with values from 28.13% to 42.36%.

4. Conclusions. The manufacture of OE yarns from combed cotton requires the following technological advantages for the processed yarn blend:

– the decreasing of the trash content in the sliver supplied at the rotor spinning machine in the rotor groove, which also determines the decreasing of neps frequency, trash remained in the yarn, faults frequency per 1,000 m yarn and yarn nonuniformity;

– the increasing of the fibre blends average tenacity and the decreasing of the nonuniformity of the processed yarns;

– the increasing of the processed yarns average fineness leads to yarns nonuniformity maintaining the same number of fibres in yarn cross-section.

The main advantage consists in the increasing of OE yarns fineness by using combed slivers on condition that the yarns uniformity be preserved, high tenacity yarns be obtained and satisfactory level of breakings/1,000 rotor hour be maintained.

Under such conditions it can be considered that the manifacture of OE combed yarns opens news perspectives for fine OE yarns.

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POSIBILITĂŢI DE EXTINDERE A LIMITEI DE FILABILITATE A FIRELOR OE CU ROTOR ÎN PRODUCEREA FIRELOR FINE

(Rezumat)

Sunt prezentate prin comparaţie caracteristici calitative ale firelor OE cu rotor realizate din bumbac cardat şi bumbac pieptănat în gama de fineţe Nm 50 – 100.

Rezultatele obţinute confirmă existenţa posibilităţilor de obţinere a unor fire mai fine cu proprietăţi fizico-mecanice superioare, prin utilizarea bumbacului pieptănat.

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Secţia VIII
TEXTILE. PIELĂRIE

STRUCTURAL MODIFICATIONS OF POLYESTER FIBRES IN THE NONWOVENS MANUFACTURING

BY

C. PREDA, MARICEL TAŞCĂ, LIVIU CIOBANU, SIMONA CIOBANU and TATIANA HARJA

The manufacturing process by carding-folding-thermal bonding influences the structure of the fibres that are present in the nonwoven wadding. Electronic microscopy, thermal analysis and physico-mechanical behaviour evidence the fibre changes.

1. Introduction. The new variants of bulky nonwoven products studied in this paper present high quality characteristics in comparison with the products realised by sewing-knitting, by needlepunching or by physico-chemical procedures with liquid adhesives [1],...,[5].

These products realised with fibrous mixture (with content of bicomponent heat-sensitive fibres) are destined both to the clothing wadding and to the furniture wadding.

As a result of the manufacturing processes by carding-folding-thermal bonding, the fibres from the obtained nonwovens suffer some modifications. This study was performed upon 3 types of fibrous mixture that contain usual polyester fibres and core-sheath heat-sensitive fibres, as follows: Mixture 1 – 15% 4.4 dtex/50 mm heat-sensitive fibres and 85% 6.6 dtex/60 mm PET 1 imported fibres; Mixture 2 – 15% 4.4 dtex/50 mm heat-sensitive fibres and 85% 6 dtex/60 mm PET 2 Romanian fibres from Corabia; Mixture 3 – 15% 4.4 dtex/50 mm heat-sensitive fibres and 85% 6 dtex/60 mm PET 3 Romanian fibres from Jassy.

The mixtures were processed by a new technology namely carding-folding-thermal bonding.

This paper proposes to present the results of undertaken studies for the evidencing of the changes which appear in fibres, both in the internal structure of polymer and in their physico-mechanical properties.

2. Experimental, Research Results and Discussions

2.1. Electronic Microscopy analysis. For scanning electron microscopy, photographs have been taken with a Tesla-Type BS300 electronic microscope. Prior to the analysis, the samples have been metallized in vacuum, with Ag, according to the principle of cathodic atomisation, then blocked mechanically on the Al metallic supports, and contacted electrically with Ag colloidal paste. The working parameters involved were the following: $U_{\text{acceleration}}$=20 kV, inclination angle=60°.

These attempts carried out by scanning electronic microscopy proposed to evidence the modifications of superficial morphology of polyester and heat-sensitive fibres after their treatment for 2 minutes at a temperature of 150°C (in a similar way with the nonwovens manufacturing parameters).

Electronic microscopy analyses have been performed upon the following samples: 1. imported PET 1 fibres; 2. Romanian PET 2 fibres; 3. Romanian PET 3 fibres; 4. imported heat-sensitive fibres; 5. imported nonwovens material; 6. Romanian nonwovens material.

The electronomicroscopic images are presented in Figs. 1,...,9.

Fig. 1.– Electronomicroscopic image of heat-sensitive fibres (×1800).

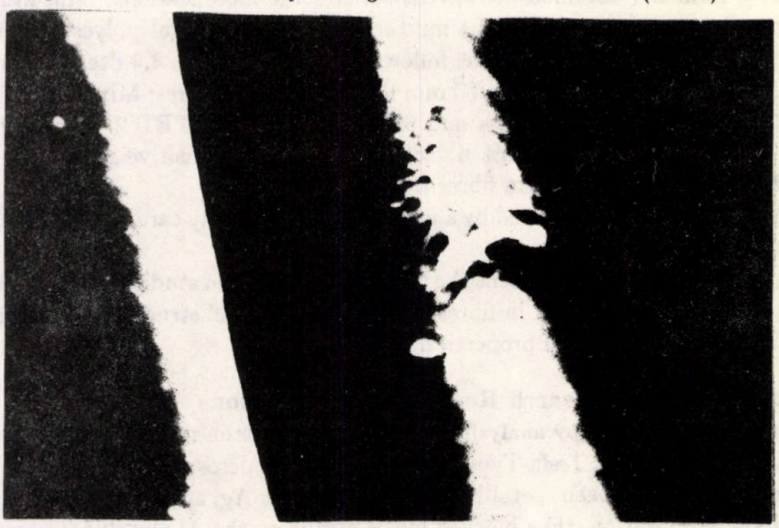

Fig. 2.– Electronomicroscopic image of untreated imported PET 1 fibres (×1800).

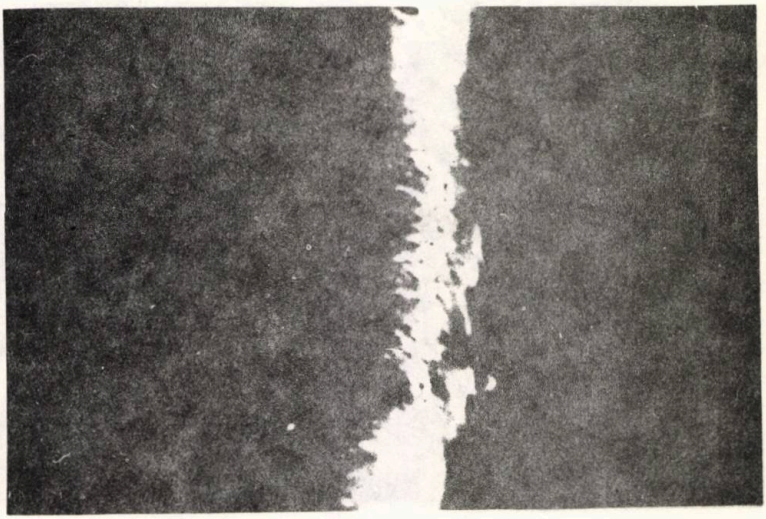

Fig. 3.– Electronomicroscopic image of PET 1 fibres treated for 2 at 150°C (×1800).

Fig. 4.– Electronomicroscopic image of untreated Romanian PET 2 fibres (×1800).

Analysing these images we can notice the following aspects:

– the heat-sensitive fibres present an oligomers' uniform distribution on the surface and at the same time a constant diameter (Fig.1);

– the imported PET 1 fibres (Fig.2) and the thermally-treated ones (Fig.3) present zones with superficial folds and microcracks-defects that can be due to the

parameters inconstancy in the spinning process and to the deviation from the cylindrical profile of the spinneret holes;

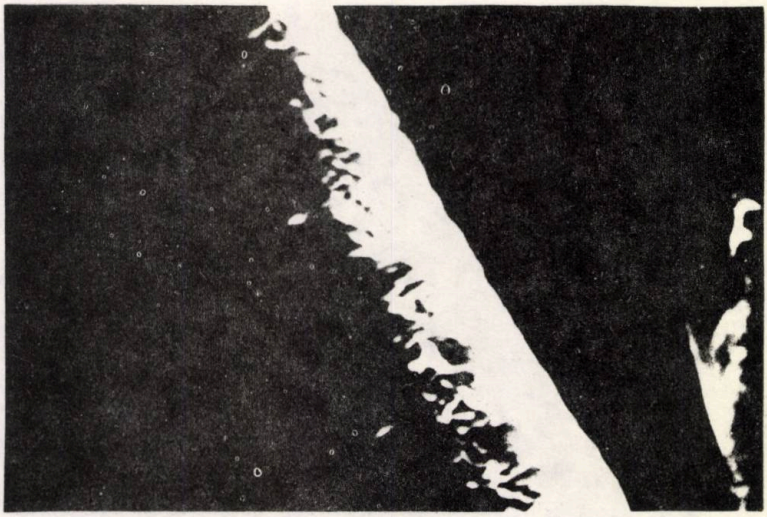

Fig. 5.– Electronomicroscopic image of Romanian PET 2 fibres treated for 2 at 150°C (×1800).

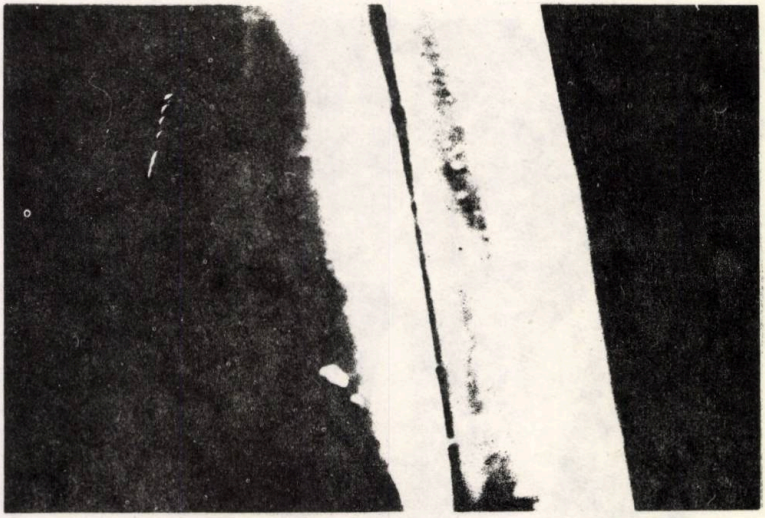

Fig. 6.– Electronomicroscopic image of untreated Romanian PET 3 fibres (×1800).

– the untreated (Fig.4) and treated PET 2 fibres (Fig.5) contain extended zones with the heat-sensitive fibres both by oligomers' uniform distribution on their surface, without fissures and microcracks and by a constant diameter.

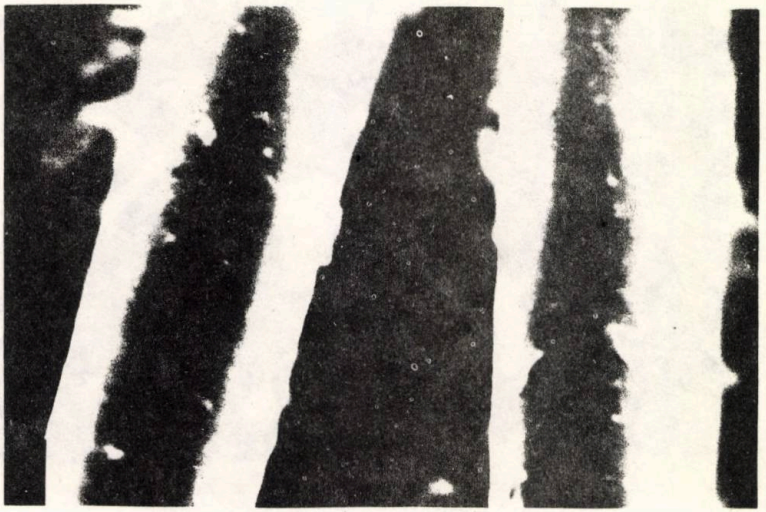

Fig. 7.– Electronomicroscopic image of Romanian PET 3 fibres treated for 2 at 150°C (×1800).

Fig. 8.– Electronomicroscopic image of imported nonwoven (×600).

From the electronomicroscopic image one can conclude that after the thermal treatment the polyester fibres do not change essentially the surface morphology.

Morphologically, the PET 3 fibres have the best characteristics.

2.2. Thermal Analysis. The technique of fibres' thermal analyses applied in the present paper are the following:

– differential thermal analysis (DTA), a dynamic procedure, permitting recording

Fig. 9.– Electronomicroscopic image of Romanian nonwoven realised with PET 2 fibres (×600).

of the DTA curves and thus evidencing of the various modifications inside the fibre, from which the initial decomposition temperature (IDT) may be calculated according to the method;

– thermogravimetric analysis (TGA), permitting measurement of the sample' massic losses as a function of temperature and time.

The modifications in weight are recorded automatically leading to a TGA curve with a gradual configuration, which illustrates the weight loss or the residual weight as a function of temperature.

DTA and TGA analyses have been developed on a Mettler TA 3000 analyser, involving recording of the corresponding curves, too. The method applied was the dynamic, thermogravimetric one, in an atmosphere of O_2, at a heating rate of 6°/min, up to a temperature of 600°C.

The curves obtained for the DTA analysis are reunited in Fig.10 and those for DTG are plotted in Fig.11.

Each of the four curves in both figures corresponds to the studied samples, as follows: untreated imported PET 1 fibres, imported PET 1 fibres treated for 2 minutes at 1500°C, untreated Romanian PET 3 fibres, Romanian PET 3 fibres treated for 2 minutes at 150°C.

PET's thermal decomposition occurs through: elimination of the small molecules (e.g. H_2O), scission of the hydrogen links, breaking of the covalent bonds including melting.

The PET fibres thermograms evidence two decomposition regions, the former between 421-425°C and the latter between 450-459°C. The endothermal peaks present in the DTA curves support such a behaviour.

The DTA and TGA thermograms for the imported PET fibres are sensibly close

to these of the Romanian PET fibres, the thermal treatment (2 minutes at 150°C) influencing only slightly thermal stability.

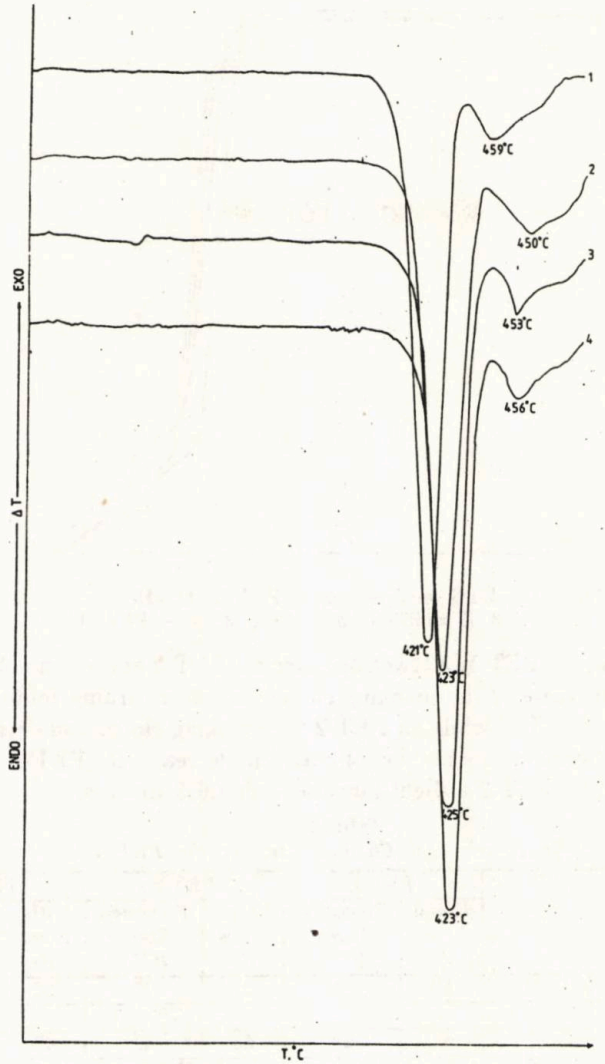

Fig. 10.– DTA analysis: *1* – PET 1; *2* – PET 1 (T=150°C); *3* – PET 3; *4* – PET 3 (T=150°C).

2.3. Changes of the Physico-Mechanical Characteristics of the Fibres. For the three types of PET fibres have been studied the following characteristics before (I) and after thermal bonding (CT): breaking resistance and elongation, number and stability of curls (Table 1 and Fig. 12).

Analysing these data one can notice a slight increase of the breaking resistance

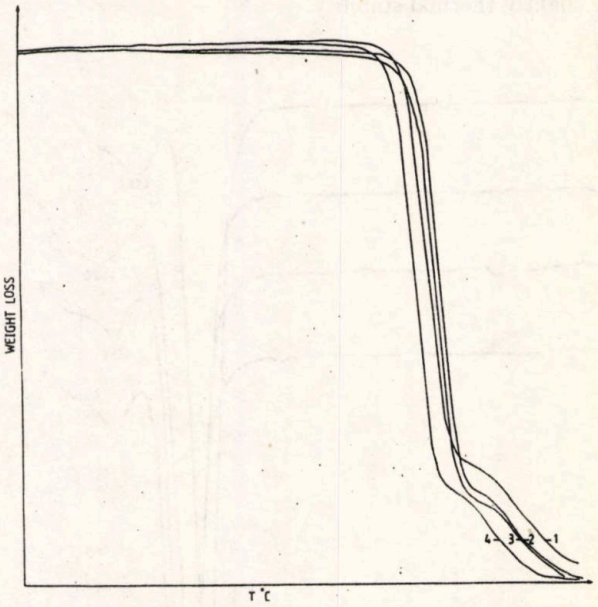

Fig. 11.– DTG analysis: *1* – PET 1 (T=150°C); *2* – PET 3 (T=150°C); *3* – PET 3; *4* – PET 1.

after the processing for PET 1, a lower decrease for PET 2 and no modification for PET 3. A slight increase of the breaking elongation after carding–folding–thermal bonding appears for PET 3, while for PET 2 the breaking elongation decreases with 3.7%. After the processing, the number of curls/cm decreases for PET 1 and PET 3 with 14...31%, and for PET 2 a slight increase with 1.6% appears.

Table 1

The Physico-mechanical Characteristics of the PET Fibres

Characteristic	UM	PET 1		PET 2		PET 3	
		Initial fibres (I)	Processed fibres* (CT)	Initial fibres (I)	Processed fibres (CT)	Initial fibres (I)	Processed fibres (CT)
Breaking resistance	cN	30	31	27	26	22	22
% changes	%	33		(–)3.703		0	
Breaking elongation	%	41	38	55	32	42	44
% changes	%	(–)7.31		(–)41.81		4.76	
Number of curls	curls/cm	3.6	3	3.1	2.55	3.75	2.6
% changes	%	(–)16.66		(–)17.74		(–)30.66	
Curl stability	%	66.97	57.38	55	55.92	58.46	40.32
% change	%	(–)14.319		1.67		(–)31.029	

The characteristic variations in correlation with the processing stage of PET fibres are presented in Fig. 13.

From the physico-mechanical point of view, PET 1 fibres are estimated as the most suitable as quality requirements for the textile nonwoven products thermally-bonded with heat-sensitive fibres.

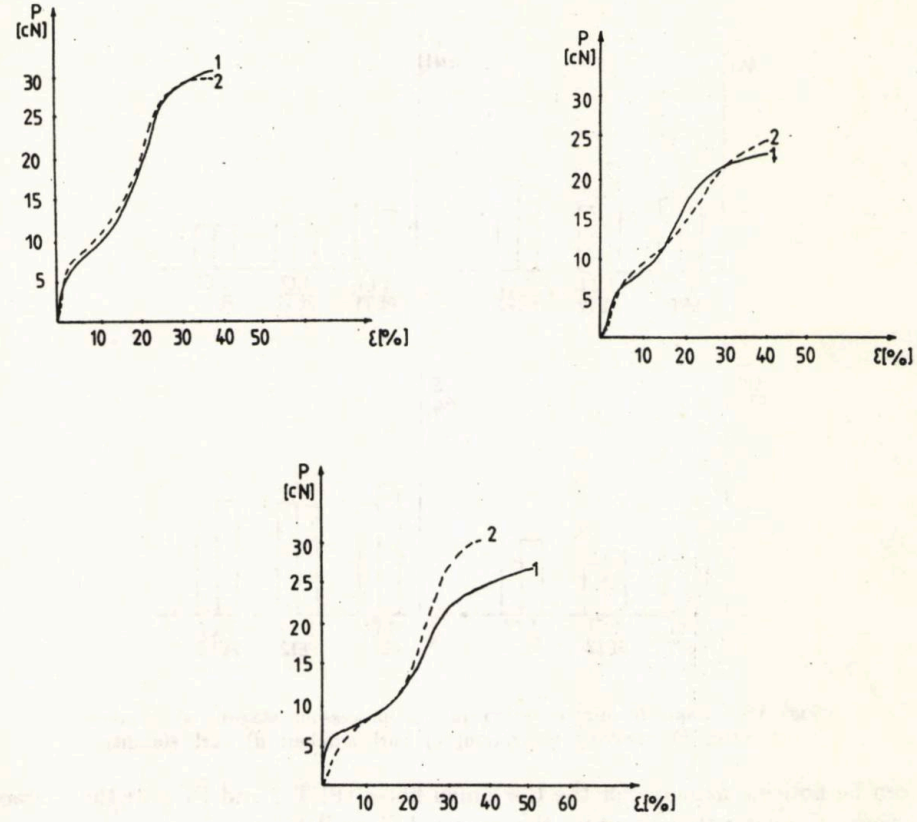

Fig. 12.– Stress-strain curves: *a*) *1.* PET 1 (I); *2.* PET 1 (CT); *b*) *1.* PET 2 (I); *2.* PET 2 (CT); *c*) *1.* PET 3 (I); *2.* PET 3 (CT).

3. Conclusions.

• As a result of electronic microscopy analysis of imported PET 1 fibres one can notice some unevennesses mainly due to the spinning process. So, zones with swellings, folds and microcracks can appear. Romanian PET 3 fibres have a good evenness due probably to the uniform distribution of the oligomers on the substrate surface. After the carding–folding–thermal bonding processing the external surface of PET 2 fibres changes, evidencing thermal degradations.

• Electronic microscopy analysis of thermally-bonded nonwovens shows a lower cover factor for the imported polyester fibres than for Romanian PET. Analysing the contact points between the heat-sensitive and the others fibres some differences

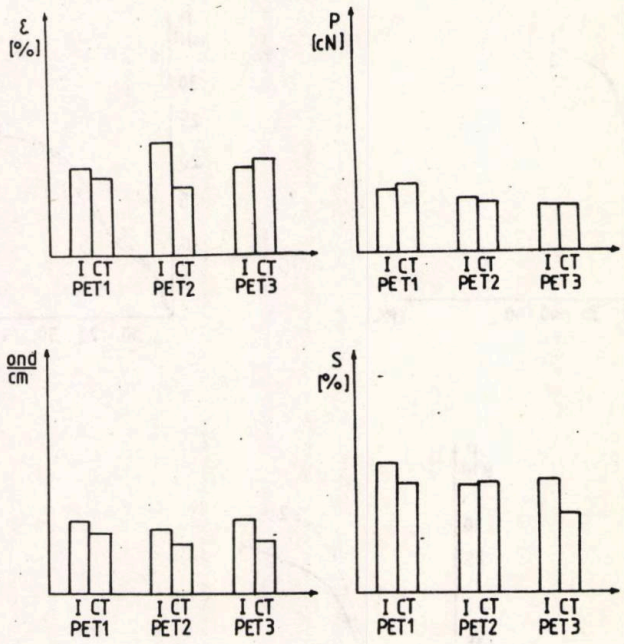

Fig. 13.– Characteristic variation in the processing stages: *a*) breaking resistance; *b*) breaking elongation; *c*) curl number; *d*) curl stability.

can be noticed, namely: for the Romanian fibres (PET 2 and PET 3) the contact zones are greater than those for the imported fibres (PET 1).

• The DTA and GTA thermograms for the imported PET 1 fibres are sensibly close to those of the Romanian ones, the thermal treatment (2 minutes at 150°C) influencing only slightly thermal stability.

• The imported fibres have the highest breaking resistance and PET 3 fibres the lowest one. After the carding–folding–thermal bonding processing the PET 3 fibres do not change their breaking resistance, the PET 2 fibres show a decrease of breaking resistance with 3.7%, while the imported fibres have an increase of 3.3% for the breaking load due to the evenness growing of the fibre structure after the thermal treatment.

• The breaking elongation decreases a lot for the PET 2 fibres (41.8%) in comparison with 7.31% for the imported fibres. The PET 3 fibres show a slight increase of elongation from 42% to 44%.

• For all the fibres, after the carding–folding–thermal bonding processing a decrease of the curl number appears, but curl stability shows a little increase for PET 2 and a slight decrease for PET 1 and PET 3 fibres.

• The settling phenomena at the finished article storing are caused by the defor-

mations in the carding–folding–thermal bonding process, and by the differences in the elastic properties and curl stability of studied fibres.

There are many ways to diminish these deformations: increase of PET thermal stability, increase of curl of number with 2-3 curl/cm, change of spinning preparation to reduce the friction coefficient between the fibres, regulation of web's delivering speed at the carding process and correlation of the curing temperature with the transport speed in the thermal bonding zone.

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MODIFICĂRI STRUCTURALE ALE FIBRELOR POLIESTERICE ÎN PROCESUL DE OBŢINERE A TEXTILELOR NEŢESUTE

(Rezumat)

Procesul de cardare–pliere–termoconsolidare influenţează fibrele din produsul final destinat vatei pentru confecţii sau tapiţerie.

Microscopia electronică, analiza termică şi comportarea fizico-mecanică ilustrează aceste modificări.

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MODELAGE MATHÉMATIQUE DU PROCESSUS DE LIAGE DES NAPPES FIBREUX EN UTILISANT LA MACHINE D'AIGUILLETAGE TYPE „FEHRER NL 36"

PAR
MARIA ZAMFIR

Sont présentés des études sur les propriétés des nontissés aiguilletés à la machine type Fehrer NL 36 (Autriche). Les recherches ont eu comme base les méthodes de programmation factoriale et méthodes statistiques.

1. Introduction. L'industrie de nontissés enregistre une plus haute productivité que les autres industries textiles, comme celles de tissage ou de tricotage [5]. Les raisons de cette productivité sont la mise en oeuvre facile au niveau de la formation de nappe fibreuse, ainsi que du processus de liage par aiguilletage ou par thermoliage [9].

Les constructeurs de machines d'aiguilletage, type Asselin (France), Automatex (Italie), Fehrer AG (Autriche) et Oskar Dilo (Allemagne), ont comme des objectifs principaux la création des machines de hautes vitesses (jusqu'aux 3000 coups par minute), ainsi que la diversité de leurs types à cause de la diversité d'utilisation des nontissés, soit au domaine doméstique, soit aux matériels pour l'industrie (comme filtres ou pour celle de la papeterie) [8], [9].

Pour les machines modernes d'aiguilletage [8], [9] les paramètres technologiques, qui caractérisent le processus de liage de la nappe fibreuse, sont: la fréquence de la planche porte-aiguilles; la profondeur de pénétration des aiguilles dans la nappe fibreuse; la densité d'implantation des aiguilles dans la planche; largeur de travail; la vitesse de sortir des nontissés.

Ces paramètres technologiques influencent les caractéristiques des nontissés et leur influence peut être étudiée à l'aide du modelage mathématique qui est traitée partiellement dans cet article [3], [4].

2. Expérimentation

2.1. Etablissement des modèles mathématiques. En utilisant un agrégat de cardage–nappage, type Alexandre & Antoine, deux nappes fibreux ont été réalisées avec une masse par unité de surface de 90 g/m^2, respectivement de 75 g/m^2. Le matériel fibreux utilisé c'est 100% fibres de polyester de 3,6 dtex en titre et de 60 mm en longueur. Ces deux nappes de fibres ont été pré-aiguilletées séparément à 450

coups/min, en utilisant une machine type Fehrer NL 9S et puis doublées et liées. Le liage finale a été effectué à une machine double d'aiguilletage type Fehrer NL 36.

Les nontissés résultés ont été destinés pour l'industrie de matériels plastiques, de maroquinerie et de chaussure comme support.

Le processus d'aiguilletage finale à la machine type Fehrer NL 36 a été réalisé en utilisant les méthodes de programmation factoriale. Ainsi a été utilisé un programme factorial, composé, central, tournabil avec deux variables indépendantes.

Les variables indépendantes considérées en cette étude sont:

• x_1, qui représente la fréquence d'aiguilletage à cinq niveaux, exprimée en coups/min;

• x_2, qui représente la vitesse d'alimentage de la nappe fibreuse dans l'espace d'aiguilletage exprimée en m/min.

Les variables indépendantes en valeurs codifées et réelles sont présentées dans le Tableau 1.

Tableau 1
Variables indépendantes

Codifiées / Variables indépendantes	−1,414	−1	0	1	1,414
x_1, [coups/min]	358,6	400	500	600	641,4
x_2, [m/min]	1,65	1,75	2,0	2,25	2,35

À la durée des expérimentations les paramètres suivantes sont restés invariables:

• la profondeur de pénétration des aiguilles dans la nappe fibreuse, à 9,7 mm;

• la densité d'implantation des aiguilles sur les planches porte-aiguilles:

⋆ 13200 aiguilles/m^2 (planche supérieure);

⋆ 14800 aiguilles/m^2 (planche inférieure);

• le type d'aiguilles: 15×18 × 32 × 3,5 RB.

Treize expérimentations ont été effectuées aléatoirement.

Le processus d'aiguilletage a été analysé par les caractéristiques de masse par unité de surface et leur comportement à la traction pour la direction transversale [3], [4].

Ainsi, les variables dépendantes qui ont été analysées sont:

⋆ Y_m représente la masse par unité de surface, [g/m^2];

⋆ Y_r représente la résistance à la rupture, [daN];

⋆ Y_a représente l'allongement de rupture, [%].

Les valeurs expérimentales des variables dépendantes pour chaque expérimentation sont présentées dans le Tableau 2.

En utilisant un programme personnel sur l'ordinateur IBM-PC 386, denommé TEXPRO [2], les modèles mathématiques:

$$(1) \qquad Y_m = 129,562 + 4,755x_1 - 0,58x_2 + 11,725x_1^2 + 1,508x_2^2 + 4,82x_1x_2,$$

$$(2) \qquad Y_r = 37,028 + 0,991x_1 - 1,192x_2 + 3,221x_1^2 - 0,811x_2^2 + 1,447x_1x_2,$$

(3) $$Y_a = 96,26 - 1,352x_1 - 3,233x_2 - 1,279x_1^2 - 0,71x_2^2 - 1,16x_1x_2$$

ont été obtenus. Ces modèles expriment mathématiquement la variation des variables dépendantes en fonction de variables indépendantes. Aussi, ces modèles permettent à définir expérimentalement les meilleures conditions de production sur le plan technique, pour l'article de nontissé donné de masse 165 g/m^2.

Tableau 2

Valeurs expérimentales des variables dépendantes et les déviations

Expérimentations	Variables indépendantes (codifiées)		Variables dépendantes et déviations					
			Masse		Résistance		Allongement	
	x_1	x_2	Y_m, [g/m^2]	A, [%]	Y_r, [daN]	A, [%]	Y_a, [%]	A, [%]
1	-1	-1	147,3200	3,0270	41,3000	0,5170	103,4800	4,9040
2	1	-1	141,3100	1,0060	39,5440	1,5930	100,7600	2,7180
3	-1	1	135,9900	2,0360	35,1360	1,9120	94,0000	0,2760
4	1	1	149,2600	2,0850	39,1680	3,8690	84,6400	2,9960
5	-1,414	0	141,5000	3,3790	42,1360	0,1640	92,0400	3,8830
6	1,414	0	163,2700	2,1680	46,1320	2,7380	91,5200	0,2950
7	0	-1,414	132,3900	0,1420	37,1280	0,0960	93,7200	7,5880
8	0	1,414	131,5000	0,8200	35,0080	3,6770	92,1200	0,4680
9	0	0	119,3000	8,6020	34,2250	8,1910	93,7080	2,7230
10	0	0	131,3700	1,3760	36,7200	0,8400	94,9200	1,4120
11	0	0	131,0700	1,1500	36,6640	0,9940	97,600	1,3730
12	0	0	136,4200	5,0270	38,4880	3,7930	96,0400	0,2290
13	0	0	129,4800	0,0640	38,9960	5,0460	98,9200	2,6890

Les coefficients de régression des modèles mathématiques ont été testés en utilisant le **Test Student** [1], [6], [7]. Les valeurs calculées t_c pour chaque coefficient de régression et la valeur théorique t_{tab} sont présentées dans le Tableau 3.

Tableau 3

Testage des coefficients de régression

Coefficients de régression	t_c			t_{tab}
	Y_m	Y_r	Y_a	
b_0	162,144	109,818	268,527	
b_1	22,705	11,175	-14,388	$\nu = 4$
b_2	-1,266	-4,994	-28,387	$\alpha = 0,05$
b_{11}	15,355	10,889	-8,237	$t_{\text{tab}} = 2,132$
b_{22}	67,796	-43,159	-1,760	
b_{12}	8,140	12,449	-10,216	

Un coefficient de régression est significatif si la valeur absolue calculée du **Test Student** dépasse la valeur théorique $t_{\text{tab}} = 2,132$ à un niveau de signifiance $\alpha = 0,05$ (avec une probabilité de 95%) et $\nu = 4$ degrés de liberté.

Les modèles mathématiques (1) et (2) nous montrent le fait que la masse par unité de surface et la résistance à la traction sont principalement influencées par la fréquence d'aiguilletage (x_1). Le modèle mathématique (3) met en évidence le fait

que l'allongement de rupture est influencé par la vitesse d'alimentage de la nappe fibreuse (x_1), mais pas fortement, voir le coefficient de I-er degré. En analysant les données du Tableau 3 on peut constater que la majorité des coefficients de régression sont significatifs, excepté que les termes b_2 de la variable Y_m et b_{22} de la variable Y_a.

Aussi, dans le Tableau 2 sont marquées les déviations A, en pour-cent, des valeurs théoriques calculées à base des modèles par rapport à celles mesurées.

Les modèles mathématiques peuvent être validés, si les déviations A, en valeur absolue, sont moins petites que la valeur de $\pm 10\%$.

Dans le Tableau 4 sont centralement présentées les données plus importantes de l'analyse statistique et de régression:

• l'adéquance des modèles (F_c), en utilisant le Test Fisher–Snedecor pour un niveau de signifiance $\alpha = 0,05$ et $\nu_1 = \nu_2 = 12$ degrés de liberté;

• les coefficients de corrélation multiple $R_{Y.x1.x2}$ et leur testage en utilisant le même Test Fisher–Snedecor à un niveau de signifiance $\alpha = 0,05$ et $\nu_1 = \nu_2 = 10$ degrés de liberté;

• les coefficients de détermination $d_{Y.x1,x2} = R^2_{Y.x1,x2}$, qui nous montrent, en pour-cent, le degré d'influence des celles deux variables indépendantes sur les variables dépendantes.

Tableau 4

L'adéquance des modèles. Testage des coefficients de corrélation

Variables dépendantes	L'adéquance des modèles		Coefficients de corrélation multiple			Coefficients de détermination
	F_c	F_{tab}	$R_{Y.x1.x2}$	F_c	F_{tab}	$d_{Y.x1.x2}$
Y_m	6,28	$\alpha = 0,05$	0,9169	26,4198	$\alpha = 0,05$	0,8407
Y_r	6,39	$\nu_1 = 12$ $\nu_2 = 12$	0,9184	26,96	$\nu_1 = 2$ $\nu_2 = 10$	0,8434
Y_a	1,94	$F_{tab} = 2,69$	0,6956	4,687	$F_{tab} = 4,1$	0,4838

Si on analyse les données des Tableaux 2, 3 et 4 les idées suivantes sont à souligner:

– les modèles mathématiques (1) et (2) expriment correctement la dépendance de la masse par unité de surface Y_m et de la résistance à la traction Y_r à rapport de la fréquence d'aiguilletage x_1 et vitesse d'alimentage x_2; cette raison est mise en evidence par les valeurs du Test Fisher-Snedecor plus hautes que la valeur théorique, ainsi que par les valeurs très hautes des coefficients de corrélation multiple de 0,9169, respective 0,9184;

– le modèle mathématique (3) n'est pas validé par le Test Fisher-Snedecor mais il peut être validé par les valeurs des déviations A (Tableau 2) moins petites que 10% à tous les treize expérimentations du programme;

– l'adéquance des modèles mathématiques (2) et (3) est aussi validée par les valeurs des déviations A moins petites que 10% (Tableau 2);

– en proportion de 15,93% et de 15,66% les variables dépendantes Y_m et Y_r sont aussi influencées d'autres facteurs avec une action nécontrolée ou difficile à controler.

On peut noter quelques facteurs: la résistance individuelle des fibres avec laquelle elles viennent à la résistance générale du nontissé; la structure de la nappe fibreuse,

parfois insuffisamment parfaite avec des fibres facilement à flotter; le déplacement des fibres à l'autre direction que celle déterminée par l'action des aiguilles à feutrage; l'usure des aiguilles pendant du processus d'aiguilletage.

L'allongement de rupture Y_a dans le sens CD (transversal) du nontissé est influencé seulement en proportion de 48,38% par les variables indépendantes du processus d'aiguilletage, mais en proportion de 51,62% d'autres facteurs. Le plus important facteur est l'allongement de rupture individuelle des fibres. Cette raison est plus significative, pour la direction de solicitation transversale, tout près d'orientation des fibres dans la nappe fibreuse – après un angle de nappage moins petit que 10°.

2.2. L'interpretation technologique des modèles mathématiques. Le modèle mathématique (1) de la masse par unité de surface Y_m, présenté sur la Fig. 1, décrit un volum parabolique avec point de minimum en valeurs réelles x_1=470 coups/min et x_2=2,12 m/min, correspondant à une valeur de 128,844 g/m^2.

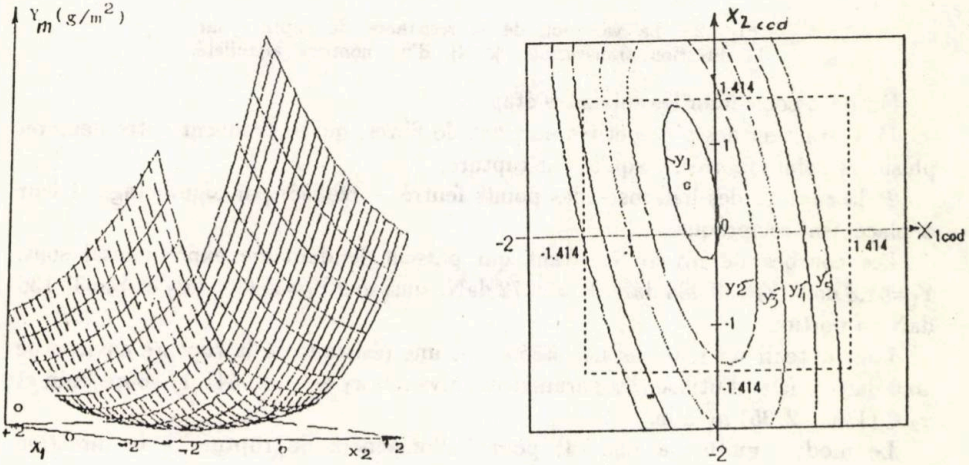

Fig. 1.– La variation de la masse par unité de surface, [g/m^2], d'un produit nontissé aiguilleté.

Le modèle mathématique (1) est représenté dans le domaine expérimental par les courbes de niveau constant Y_1=129,48 g/m^2, Y_2=132,29 g/m^2, Y_3=135,99 g/m^2, Y_4=141,5 g/m^2 et Y_5=147,32 g/m^2. En conclusion, pour obtenir un nontissé de masse de 150 g/m^2 utilisé comme support textil pour des materiels plastiques, chaussure et maroquinerie, les variables indépendantes considérées doivent d'avoir les valeurs: $x_1 \in (605...641,4)$ coups/min et $x_2 \in (1,65...2,35)$ m/min.

Le modèle mathématique (2) de la résistance à la traction Y_r présenté sur la Fig.2 décrit un volume hyperbolique avec un point stationnaire de minimum/maximum denommé aussi „point selle", x_1=501 coups/min et x_2=1,82 m/min, correspondant à une valeur de résistance de 37,466 daN.

L'existence d'un point de minimum/maximum est expliquée par le fait que le mécanisme de rupture des nontissés aiguilletés englobe principalement deux étapes, qui se succédent alternativement, jusqu'à la résistance maximale.

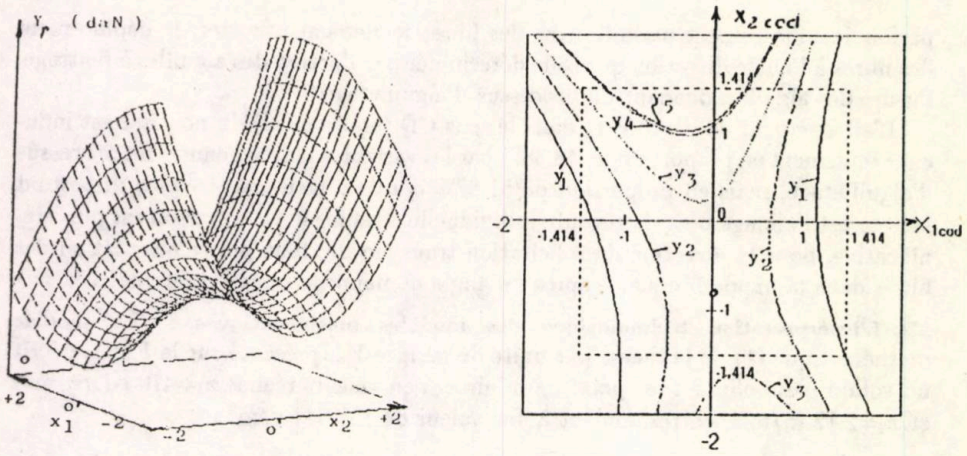

Fig. 2.– La variation de la résistance de rupture sur la direction transversale, [daN], d'un nontissé aiguilleté.

On peut considérer les suivantes étapes:

1° la traction des plus petites portions de fibres, qui se trouvent entre deux ou plusieurs points feutrés, jusqu'à leur rupture;

2° la rupture des liaisons – des points feutrés – réalisés par aiguilletage et leur déplacement réciproque.

Les courbes de niveau constant qui passent le domaine expérimental sont: Y_1=41,3 daN, Y_2=38,488 daN, Y_3=36,72 daN, ainsi que Y_4=35,008 daN et Y_5=35,136 daN en portions.

Pour obtenir un matériel nontissé ayant une résistance à la rupture environ de 40,0 daN, il faut d'utiliser les paramètres suivants: $x_1 \in (610...641,1)$ coups/min et $x_2 \in (1,65...2,35)$ m/min.

Le modèle mathématique (3) pour l'allongement de rupture à la direction transversale Y_a est présenté sur la Fig.3.

Il décrit un volum hyperbolique ascendant avec un point stationnaire de minimum (Fig.3), de coordonnées x_1=221 coups/min et x_2=3,24 m/min, correspondant à un allongement de rupture de 90,091%.

Les valeurs résultées de la fréquence d'aiguilletage x_1 et de la vitesse d'alimentage x_2 ne sont pas dans le domaine expérimental, mais elles peuvent être techniquement réalisées.

La décroissance d'allongement de rupture c'est la conséquence d'agrandissement des points feutrés par l'aiguilletage.

Les courbes Y_2=94,0%, Y_3=92,04%, Y_4=97,6% et Y_5=91,52% passent partiellement le domaine expérimental.

L'allongement de rupture des nontissés est influencé principalement par les caractéristiques d'élasticité des fibres constituantes, qu'imposent habituellement les destinations des nontissés.

Les matériels de cette étude, destinés comme support dans un processus chimique

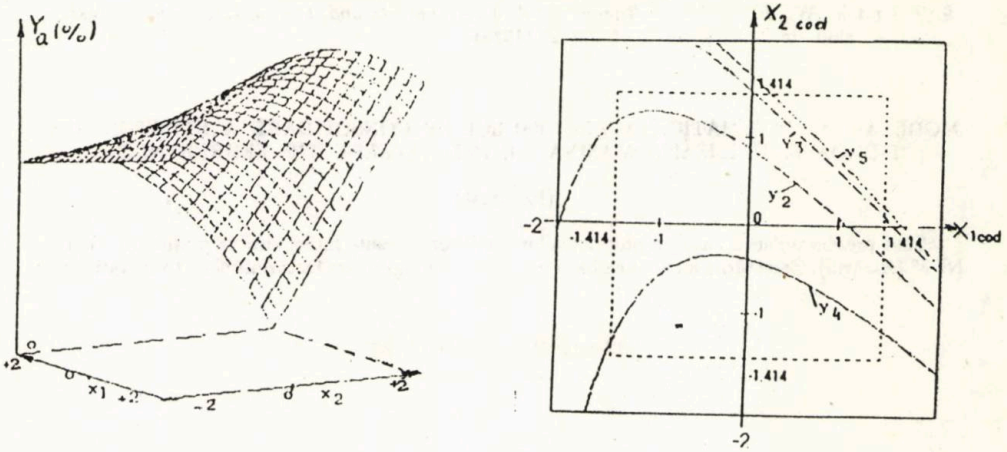

Fig. 3.– La variation d'allongement de rupture, [%], à la direction transversale d'un nontissé aiguilleté.

pour les plastiques, chaussure et maroquinerie, doivent d'avoir un haut allongement pendant le processus chimique.

Donc, un allongement haut de 97,6% on peut obtenir aux paramètres suivants: $x_1 \in (358,6...641,4)$ coups/min et $x_2 \in (1,65...1,94)$ m/min.

3. Conclusions. Les expérimentations efectuées, en utilisant la machine double d'aiguilletage type „Fehrer NL 36", soulignent le fait que la fréquence d'aiguilletage influence fortement les caractéristiques des nontissés.

Le processus d'aiguilletage peut être étudié à l'aide du modelage mathématique. Les modèles mathématiques résultés, ainsi que leurs représentations graphiques permettent l'établissement des conditions optimaux de mise en oeuvre pour un matériel nontissé donné.

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MODELAREA MATEMATICĂ A PROCESULUI DE CONSOLIDARE A STRATURILOR FIBROASE, UTILIZÂND MAŞINA DE INTERŢESERE TIP FEHRER NL 36

(Rezumat)

Sunt prezentate studii asupra proprietăţilor textilelor neţesute interţesute la maşina tip Fehrer NL 36 (Austria). Cercetările au avut ca bază metodele de programare factorială şi metode statistice.

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Secţia VIII
TEXTILE. PIELĂRIE

L'INFLUENCE DES PARAMÈTRES D'AIGUILLETAGE SUR LA MASSE SURFACIQUE DES NONTISSES

PAR
GEORGE CIUBOTARU et MARIA ZAMFIR

Dans cet article sont étudiés les paramètres technologiques du processus d'aiguilletage ayant une influence significative sur la masse surfacique des nontissés, de fibres virgines et recyclées, destinés pour des travails de drainage des terraines agricoles.

1. Introduction. La caractéristique de masse surfacique est la plus importante pour les nontissés. Cette caractéristique détermine la destination des nontissés, assez diversifié, à partir des matériels auxiliaires pour habillement ainsi que des matériels utilisés aux domaines techniques [4].

Les nontissés aiguilletés peuvent d'être de masse surfacique à partir de 100 g/m^2 jusqu'à 1000 g/m^2. Des nontissés aiguilletés ayant 2000 g/m^2 peuvent être aussi produits.

Le but de cette recherche est d'établir le degré d'influence des plus importants paramètres d'aiguilletage sur la masse d'un nontissé destiné pour des travails de drainage des terrains agricoles.

2. Résultats. La recherche a été effectué sur un mélange fibreux ayant 50% polypropylène de 16,5 dtex en titre et 107,8 mm en longueur, et 50% polyacrylonitril recyclés d'environ 65 mm de longueur moyenne. La choisir des cettes sortes de fibres est déterminée par leurs propriétés et que les fibres recyclées sont bon marchées.

La nappe fibreuse a été realisée par le processus de cardage-nappage. La masse surfacique de la nappe fibreuse soumise à l'aiguilletage a été, en valeur moyenne, de 200 g/m^2.

Une machine d'aiguilletage, simple avec une seule planche porte-aiguilles, de baisse productivité, a été utilisée à la durée des expérimentations.

Les paramètres d'aiguilletage considérés importantes [2], [4] à la durée de recherche ont été les suivants:

- l'avance de la nappe fibreuse par coup, exprimée en mm, notée x_1;
- la fréquence de la planche porte-aiguilles, qui représente le nombre des coups par minute de la planche, exprimée en cycles/min, notée x_2;
- la profondeur de pénétration des aiguilles dans la nappe fibreuse, exprimée en mm, notée x_3.

Les expérimentations ont été effectuées aléatoirement sur la base d'un programme composé, central, rotatif [3],...,[5].

Dans le Tableau 1 sont présentés: le programme expérimental et les valeurs mesurées de la masse surfacique des variantes de nontissés résultées à la durée de recherche.

Tableau 1

Programme expérimental. Valeurs mesurées de la masse volumique

Nombre de expéri-mentations	Ordre des expéri-mentations	Valeurs des paramètres						Valeurs mesurées Y_M
		Codifiées			Naturelles			
		x_1	x_2	x_3	x_1	x_2 cycles/min	x_3	
					mm		mm	g/m^2
1	19	−1	−1	−1	4	88	8	168,28
2	8	1	−1	−1	10	88	8	209,66
3	13	−1	1	−1	4	146	8	123,83
4	18	1	1	−1	10	146	8	241,65
5	5	−1	−1	1	4	88	14	246,43
6	17	1	−1	1	10	88	14	195,80
7	4	−1	1	1	4	146	14	170,73
8	10	1	1	1	10	146	14	258,10
9	3	−1,682	0	0	2	117	11	182,90
10	11	1,682	0	0	12	117	11	178,44
11	16	0	−1,682	0	7	69	11	174,92
12	12	0	1,682	0	7	165	11	210,55
13	15	0	0	−1,682	7	117	66	201,43
14	2	0	0	1,682	7	117	16	295,44
15	6	0	0	0	7	117	11	189,08
16	20	0	0	0	7	117	11	204,21
17	7	0	0	0	7	117	11	197,50
18	1	0	0	0	7	117	11	191,84
19	14	0	0	0	7	117	11	218,96
20	9	0	0	0	7	117	11	183,10

La dépendance mathématique de la masse surfacique, en fonction des paramètres d'aiguilletage considérés, est donnée par la relation:

$$(1) \qquad \begin{aligned} Y_M = {} & 211,083 + 18,711x_1 + 2,495x_2 + 20,925x_3 - 23,702x_1^2 - 4,567x_2^2 + \\ & + 15,130x_3^2 + 34,253x_1x_2 - 7,859x_1x_3 - 0,117x_2x_3. \end{aligned}$$

Pour ce modèle ont été effectué des testages, sur les coefficients de regression, l'adéquence du modèle, le coefficient de correlation multiple et de détermination, en utilisant les tests STUDENTS et FISHER-SNEDECOR. Toutes les données statistiques ont été complétement présentées dans le cadre d'article [5].

Dans l'actuel étude sont présentées, en détail, plus des explications concernant, seulement, l'influence de l'avance (x_1) et de la fréquence de la planche porte-aiguilles (x_2). Cet étude a été aussi imposé par la complexité du processus d'aiguilletage, d'arrangement des fibres dans la nappe, pas exactement contrôlé, et pour savoir mieux tous qui se passe à la durée d'un tel processus.

3. Interprétations. Si on considère que la profondeur de pénétration des aiguilles dans la nappe fibreuse est de valeur centrale du programme, c'est-à-dire, la valeur naturelle de 11 mm, alors la relation (1) peut être écrite à la manière:

$$(2) \qquad \begin{aligned} Y'_M = {} & 211,083 + 18,711x_1 + 2,495x_2 + 20,925x_3 - \\ & - 23,702x_1^2 - 4,567x_2^2 + 34,253x_1x_2 \end{aligned}$$

La relation mathématique (2) est représentée graphiquement sur la Fig. 1 par: la représentation volumique; les courbes de réponse de niveau constant; la variation de la masse en fonction de chaque paramètre séparément, quand l'autre est à la valeur du centre expérimental.

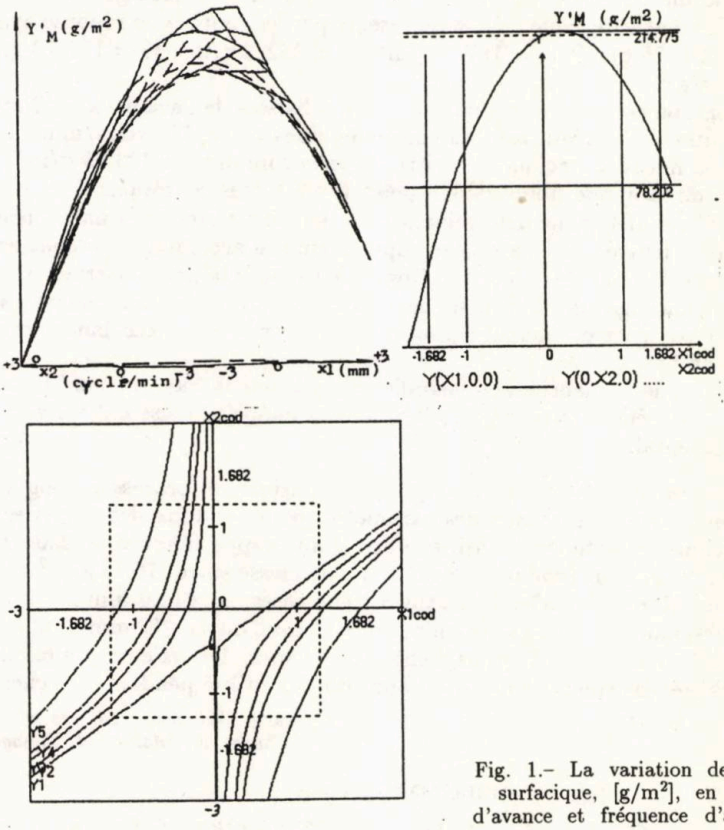

Fig. 1.– La variation de la masse surfacique, [g/m^2], en fonction d'avance et fréquence d'aiguilletage.

En analysant le modèle mathématique (2) et la Fig. 1, on peut constater que la variation de la masse surfacique décrit, en fonction de paramètres d'aiguilletage, un corps volumique hyperbolique, n'ayant pas un point de minimum/maximum situé au cadran IV-ème et tout près de centre expérimental.

Le point de minimum/maximum est de coordonnées $x_1 = 7$ mm et $x_2 = 101$ cycles/min, dont lui correspond une valeur de $Y = 211,083$ g/m^2 pour la masse surfacique. L'existence d'un point de minimum/maximum s'explique de la manière suivante: pour obtenir une telle valeur de la masse surfacique à une paramètre qui augmente en valeur, alors le deuxième paramètre doit décroitre.

Si on analyse les courbes de niveau constant et la variation de la masse surfacique, en fonction d'un paramètre quand le deuxième et le troisième sont aux valeurs du centre expérimental, les idées suivantes sont à souligner:

– l'avance a, nettement, une influence semnificative sur la masse surfacique des nontissés;

– l'augmentation de l'avance, à partir de valeur de 2 mm jusqu'a la valeur de 12 mm, détermine l'augmentation de la masse, ayant un point de maximum à la valeur de $x_1 = 7,8$ mm pour laquelle correspondra la valeur de 214,775 g/m^2. Après cette valeur la masse surfacique baisse jusqu'à la valeur de 78,202 g/m^2;

– le modèle mathématique (2) est représenté par les courbes de réponse ayant les valeurs $Y_1 = 210,55$ g/m^2; $Y_2 = 197,5$ g/m^2; $Y_3 = 182,9$ g/m^2; $Y_4 = 170,73$ g/m^2 et $Y_5 = 123,83$ g/m^2.

Finalement, on constate que, pour des valeurs baisses de l'avance $x_1 \in$(2 mm . . . 4 mm) et hautes de la fréquence de la porte-aiguilles $x_2 \in$(117 cycles/min . . . 165 cycles/min), la masse surfacique enregistre la valeur minime de 123,83 g/m^2, moins que la masse de la nappe fibreuse. On peut dire à cettes conditions de travail que le processus d'aiguilletage ne détermine pas un liage des fibres de la nappe résultant des points forts feutrés. Un laminage supplémentaire accompagne le feutrage par des ruptures des liaisons des fibres résultés au feutrage. On peut constater vraiment un aspect de „hachage" des fibres, sur le matériel, et par suite de la nappe fibreuse. Finalement, l'existence des défauts grands, comme certains orifices dans le matériel, sont de plus en plus évidents.

La fréquence de la planche port-aiguilles n'a pas une influence quand l'avance et la profondeur de pénétration des aiguilles dans la nappe fibreuse ont les valeurs du centre expérimental.

4. Conclusions. A la base de modélage mathématique du processus d'aiguilletage étudié on peut établir les valeurs des paramètres pour produire des nontissés d'une masse surfacique déterminée. Ainsi, à partir d'une nappe fibreuse de 200 g/m^2 en masse surfacique et pour produire des nontissés de masse entre 170,73 g/m^2 et 210,55 g/m^2, les paramètres doit d'avoir les valeurs suivantes: $x_1 \in$(2,0 mm . . . 7 mm); $x_2 \in$(69 cycles/min . . . 165 cycles/min); $x_3 =$11 mm, ou $x_1 \in$(7 mm . . . 12 mm); $x_2 \in$(69 cycles/min . . . 117 cycles/min); $x_3 =$11 mm. Les valeurs des paramètres sont valables, généralement, pour le mélange fibreux utilisé pendant la recherche.

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INFLUENŢA PARAMETRILOR DE INTERŢESERE ASUPRA MASEI PE UNITATEA DE SUPRAFAŢĂ A MATERIALELOR NEŢESUTE

(Rezumat)

Se prezintă un studiu privind stabilirea valorilor parametrilor procesului de interţesere pentru a produce materiale neţesute de masă dată. Realizarea acestui scop a fost posibilă prin folosirea elementelor de modelare matematică.

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TEXTILE. PIELĂRIE

EVALUATION OF THE NEEDLEPUNCHED NONWOVEN GEOTEXTILES PROPERTIES

BY

FLORENTINA PĂTRĂŞCAN-COSTACHE and MARIA ZAMFIR

The effects of the needlepunching density and fiber fineness on the basic weight of the nonwoven geotextiles made of polyester fibers are presented.

1. Introduction. Geotextiles are the technical textiles used in the works of soil. The complex uses functions and properties of the geotextiles have ascertained that they could be produced by the variedest technics as needlepunching, SPUNBONDED or composite materials. The needlepunch technology, very popular in the nonwovens industry, can be used to bond all fiber types. Usually, the needlepunched nonwoven geotextiles are made of polyester fiberwebs [1], [2], [6].

In this paper, the basic weight of the nonwoven geotextiles is approached by the help of mathematical modelling. The objective of this work was to study the influence of two process variables, needlepunching density and fiber fineness, on the basic weight for the nonwovens made of polyester fibers.

2. Experimental. Two process variables, needlepunching density and fiber fineness were studied by using a central compound rotative experimental plan for the partial factorial design [3], [5]. The codified and real levels of two factors, used in the experiment, are given in Table 1. The process was of feeded-blended-preopened fibers, carded-layered and needlepunched with the Befama – Metalul Roşu (Poland – România) countries machinery. Before the needlepunching process, the average basic weight of the layered web was of 400 g/m^2 for every experiment.

3. Results and Discussion. All data of the average basic weight are given in the Table 2, and they were used to establish the relationship:

$$(1) \quad Y = 408,378 + 4,533x_1 + 16,739x_2 + 18,447x_1^2 - 32,162x_2^2 - 12,5x_1x_2,$$

between the process variables and this property of the nonwoven geotextiles. Data was fit by using the TEXPRO PC Software [4].

The regression coefficient were tested with the Student statistical using [3], [4]. The calculated values of Student t_c more high as $t_{tab} = 2.132$ table value indicate that the process variables accounted for the variability of the data. This statistic

Table 1
Levels of the Process Variables Used in the Experiment

Codified Levels	Process Variables	
	x_1 Needlepunching density punch/cm^2	x_2 Fiber fineness den
−1,414	20	4
−1	38	6
0	80	8
+1	122	10
+1,414	140	12

Table 2
Data of the Average Basic Weight

Experiment number	Experimental data Y, [g/m^2]
1	364,6
2	399,6
3	389,25
4	374,25
5	452,4
6	463,9
7	309,3
8	404,5
9	408,6
10	408,5
11	408,3
12	407,9
13	408,1

is presented in Table 3. It can seen that all regression coefficients are generally significant at $\alpha = 0.05$ minimum significance level and $\nu = 4$ degrees of freedom. The multiple correlation coefficient $R_{Y \cdot x_1, x_2} = 0.8908$ expresses a high degree of influence of the both process variables on the basic weight.

Table 3
The Calculated Values of Student Statistic

Regression Coefficients	Student Statistic (t_c)	Critical Student Values to Compare
b_0	3188.9	
b_1	44.77	*Minimum:* $t_{tab} = 2.132$
b_2	165.337	at $\alpha = 0.05$ and $\nu = 4$
b_{11}	169.882	
b_{22}	−296.184	*Maximum:* $t_{tab} = 8.601$
b_{12}	−87.304	at $\alpha = 0.0005$ and $\nu = 4$

The predicted responses are shown, as three dimensional bar graphs and the responding curves, in Fig. 1. The data of the constant level response curves Y_1 to Y_5 are the following: $Y_1 = 389.25$ g/m^2; $Y_2 = 399.6$ g/m^2; $Y_3 = 408.5$ g/m^2; $Y_4 = 415$ g/m^2 and $Y_5 = 420$ g/m^2.

All graphs are plotted with the codified values, used in the experimental region, as (−1.414...1.414) and more (−2...2) intervals. The variation of basic weight is like hyperbolical body and has the saddle point at 410.834 g/m^2. This value is possible to be obtained with the process variable values, close to the experimental region centre: $x_1 = -0.033$ and $x_2 = 0.267$ codified values, or $x_1 = 79$ punch/cm^2 and $x_2 = 8.53$ den of real values.

The growth of fiber determines first the growth of the basic weight and it decreases when the fiber titre are in the (0...1.414) interval of values. The growth of fiber titre determines the decrease of the needlepunched points number during the process. The thick fibers are generally more rigid and are not easily needlepunched.

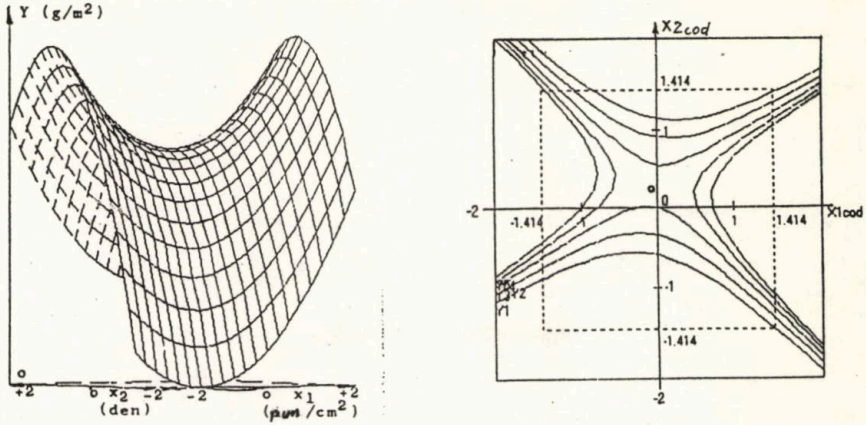

Fig. 1.– The predicted responses of the needlepunched nonwoven basic weight, [g/m^2].

4. Conclusions. The nonwoven geotextiles properties are influenced by the fibers properties like fiber fineness and the geotextiles structure shown by the needlepunched points of the fibers.

The graphs of the obtained responding curves can be used to establish the best process variables to produce according to the nonwoven geotextiles required by the consumers.

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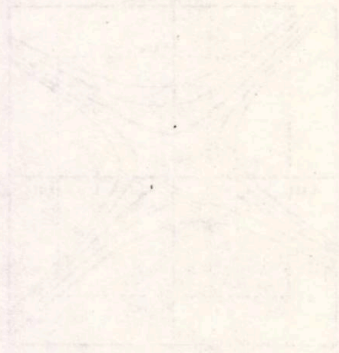
EVALUAREA PROPRIETĂŢILOR GEOTEXTILELOR DIN MATERIALE NEŢESUTE OBŢINUTE PRIN INTERŢESERE

(Rezumat)

Sunt prezentate efectele densităţii de interţesere şi fineţii fibrelor asupra masei pe unitatea de suprafaţă a geotextilelor neţesute realizate din fibre poliesterice.



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FORSCHUNGEN ÜBER VERZUGSKRÄFTEN

VON

MARIUS CARAIMAN und MIRCEA NETEA

Eigene Forschungen, betreffend Verzugskräfte sind in 2 Richtungen orientiert worden: Realisierung einer eigenen Vorrichtung für experimentelle Bestimung der Verzugskraft, und Bestimmung der Verzugskraft auf Streckwerken.

Die Messung der Verzugskraft während des Betriebes der Maschine erfolgte mittels einer Vorrichtung origineller Konzeption und Realisierung. Die registrierten Werte gehören den wenigen konkreten Werte an, die auf internationaler Ebene registriert wurden. Mit Hilfe der erwähnten Vorrichtung gelang es den Einfluß einiger technologischen Parameter (Belastung des Streckwerkes, Streckenweite im kritischen Raum, Faserfeinheit, Nadeldichte r Nadelbarette, Avivage) auf die spezifische Verzugskraft zu ermitteln. Diese Ermittlungen erfolgten auf Bänden aus Polyesterfasern (Durchgand I, II, III aus der Konverterabteilung) auf SN 10- Streckwerken.

1. Kurze Betrachtungen über die Verzugskräfte. Die Verzugskraft ist ein Grundmaß im Rahmen der Faserverarbeitung (Faserbewegung im Streckwerk), welche mit gleicher Aufmerksamkeit wie die anderen Aspekte und technologischen Parameter geforscht und analysiert werden müßte. Diese ist ein Parameter in Kammwollespinnereien und Halbkammvollespinnereien um so interessanter als die Faserleit – und überwachungsvorrichtungen im Streckfeld (Nadelbaretten) einen besonderen Einfluß auf diese Kräfte haben.

Die Verzugskraft ist von 2 Faktorengruppen beeinflußt: a) technologische Faktoren und b) bauliche Faktoren.

Die technologischen Faktoren beinhalten: Natur des verarbeiteten Faserstoffes, Diagramme relativer und zusammengesetzten Frequenzen der Faserlängeverteilung, positive oder negative Abweichungen betreffend Längeeinheitsmasse des ngelaufenen Produktes, Nadeldichte und Querschnittform der Nadelbarette, Längs- und Quermischungshomogenität, Orientierungs- und Parallelisierung grad der dem Verzug unterzogenen Fasern, Einfluß der Mitteln gegen elektrostatische Aufladung und der Produkte der Einölungungsemulsionen, Verzugsgröße, Verzugsgeschwindigkeit, Streckweite in dem kritischen Raum, Belastungskräfte auf die Verzugszylinder, Größe der Dublierung im Einlaufbereich, Torsionkoeffizient.

Die baulichen Einflußfaktoren sind: Typ und System des Streckwerkes, Lagerungsart der Verzugszylinder, Riffelprofil der unteren Verzugszylinder, Art des Druckzylinderüberzuges, Präzision der Erzeugung von Bauteilen der ganzen Maschine und besonders von Bauteilen der Verzugseinrichtung.

Die Verzugskraft kann durch verschiedene Methoden gemessen werden: statische und dynamische.

Die statische Meßmethode basiert sich auf die simultane Bestimmung der Haftkraft mit gleichzeitiger Vergrößerung des Abstandes zwischen den Klemmen und mit simultaner graphischer Registrierung des Kraft-Dehnungsdiagrammes.

Solche Versuche sind einfach aber sie können die auftretenden physischen Phänomene nicht wiederspiegeln. Aus diesem Grund müssen sie im einem Streckwerk, dessen Bestandteilesich in Bewegung befinden, analysiert werden.

Die Messung der Verzugskraft durch dynamische Methode erfolgt kontinuierlich, gleichzeitig mit dem Faserdurchgang durch das Streckwerk.

Die technische Fachliteratur umfaßt bis jetzt eine Reihe von Studien zur Messung der Verzugskraft mittels bestimmter Typen von Apparaten und für verschiedene Fasertypen, [1],...,[4].

2. Experimentierprogramm

2.1. Varianten und Experimentierbedingungen. Das durchgeführte Experiment hatte als Ziel, den Einfluß der Streckwerksbelastung mit Fasern (T_A) und der Streckweite im kritischen Raum (E) auf die spezifische Verzugskraft (F_{SL}), im Falle der Verarbeitung von wollartigen Polyesterfasern auf einem Streckwerk mit Doppelnadelfeld zu beobachten.

Der Einfluß der beiden technologischen Parameter auf die spezifische Verzugskraft wurde unter verschiedenen Verarbeitungsbedingungen beobachtet, die sich auf die Nadeldichte der Nadelbarette und auf den realen Wert des auf der Maschine festgestgelegten Verzuges.

Das Experiment wurde unter 3 verschiedenen Verarbeitungsbedingungen realisiert. Die Regelparameter und die Experimentierbedingungen sind aus der Tabelle 1 zu entnehmen.

Tabelle 1

Regelparameter	Experimentierbedingungen		
	I	II	III
Titer der eingelaufenen Bänder – T_a (ktex)	17,5		19
Streckweite im kritischen Raum – E (mm)	25		
Titer der ausgelaufenen Bänder – T_d (ktex)	17,5	19	20
Nadeldichte der Nadelbarette – D_b (Nadel/cm)	6	7	8
Druck auf Auslaufzylinder – P (daN)	250		
Fasersortiment	Polyester 4 den/75 mm		

2.2. Ergebnisse der experimentallen Bestimmungen

2.2.1. Einfluß der Faserbelastung des Streckwerkes (T_A). Für jede der 3 erwähnten Verarbeitungsbedingungen wurdei 3 Experimentiervarianten realisiert.

Die Mittelwerte der einzeluen Experimentierbestimmungen bezüglich Größe der spezifischen Verzugskraft in Abhängigheit von der Faser belastung des Streckenwerkes werden zentralisiert in den Tabellen 2, 3 und 4 dargestellt.

2.2.2. Einfluß der Streckweite im Kritischen Raum E (mm). Für jede der 3 vorher augegebenen Verarbeitungsbedingungen wurden verschiedene Experimentiervarianten realisiert. Und zwar, wurden 4 Varianten unter ersten Experimentierbedingungen und je 6 Varianten unter den anderen Experimentierbedingungen realisiert.

Die Mittelwerte der einzelnen experimentallen Bestimmungen bezüglich Größe der spezifischen Verzugskraft in Abhängigheit mit der Streckweite im kritischen

Tabelle 2

Experimentierbedingungen I (D_b=6 Nadel/cm)

Einflußfaktoren und Wert der Verzugskraft	Varianten		
	V_1	V_2	V_3
Dublierung	8	10	12
Faserbelastung des Streckwerkes T_A=$T_a \cdot D$ (ktex)	140	175	210
Gesamtverzugskraft F_L (cN)	760	1330	1900
Spezifische Verzugskraft F_{SL}=F_L/T_d (cN/ktex)	43,45	76,00	108,40

Tabelle 3

Experimentierbedingungen II (D_b=7 Nadel/cm)

Einflußfaktoren und Wert der Verzugskraft	Varianten		
	V_1	V_2	V_3
Dublierung	8	10	12
Faserbelastung des Streckwerkes T_A=$T_a \cdot D$ (ktex)	140	175	210
Gesamtverzugskraft F_L (cN)	2660	2660	3040
Spezifische Verzugskraft F_{SL}=F_L/T_d (cN/ktex)	120	120	160

Tabelle 4

Experimentierbedingungen III (D_b=8 Nadel/cm)

Einflußfaktoren und Wert der Verzugskraft	Varianten		
	V_1	V_2	V_3
Dublierung	8	10	12
Faserbelastung des Streckwerkes T_A=$T_a \cdot D$ (ktex)	152	190	228
Gesamtverzugskraft F_L (cN)	3420	3610	2470
Spezifische Verzugskraft F_{SL}=F_L/T_d (cN/ktex)	171	180,5	193,5

Raum werden zentralisiert in den Tabellen 5, 6 und 7 dargestellt.

Tabelle 5

Experimentierbedingungen I (D_b=6 Nadel/cm)

Einflußfaktoren und Werts der Verzugskraft	Varianten			
	V_1	V_2	V_3	V_4
Streckweite E (mm)	25	30	35	40
Verzugskraft F_L (cN)	2280	1900	1520	950
Spezifische Verzugskraft F_{SL}=F_L/T_d (cN/ktex)	130	108,4	87	54,25

Tabelle 6

Experimentierbedingungen II (D_b=7 Nadel/cm)

Einflußfaktoren und Wert der Verzugskraft	Varianten					
	V_1	V_2	V_3	V_4	V_5	V_6
Streckweite E (mm)	25	30	35	40	45	50
Verzugskraft F_L (cN)	2280	1710	2660	2850	2660	2850
Spezifische Verzugskraft F_{SL}=F_L/T_d (cN/ktex)	120	90	140	150	140	150

Tabelle 7

Experimentierbedingungen III (D_b=8 Nadel/cm)

Einflußfaktoren und Wert der Verzugskraft	Varianten					
	V_1	V_2	V_3	V_4	V_5	V_6
Streckweite E (mm)	25	30	35	40	45	50
Verzugskraft F_L (cN)	2280	2470	2470	3040	3040	3420
Spezifische Verzugskraft F_{SL}=F_L/T_d (cN/ktex)	114	123,5	123,5	152	152	171

3. Schlußfolgerungen. Nicht zahlreich sind die Realisierungen auf dem Gebeit der Erzeugung von Apparaten, die die Bestimmung der Verzugskräfte durch dynamische Methoden erlauben.

Zu diesem Zweck dient die Erzeugung des Apparates, mit welchem die Bestimmungen aus dem vorliegenden Studium vorgenommen wurden. Trotzdem der Apparat zur Messung der Verzugskraft im dynamischer Betriebsweise auf einem Streckwerk mit doppelter Nadelebene verwendet wurde, kann dank seine Konstruktion auch an anderen Bauvarianten von Streckwerken leicht angepaßt werden.

Die Experimentierungen haben den entscheidenden Einfluß der Streckwerkbelastung und der Streckweite auf die Verzugskraft hervergehoben.

In der technischen Fachliteratur wurden diese Einflüsse mit anderen Typen von Apparaten aber bei anderen Faserkategorien herausgehoben.

Die Resultate der Experimentierungen können auch von anderen Parametern beeinflußt werden, die wegen ihrer großer Auzahl und ihrer Komplexität nicht genau bestimmt werden können. Wenn vertiefte Auslysen durchgeführt werden, müssen darunter folgende Parameter in Betracht gezogen werden: Ungleichmäßigkeit der bearbeiteten Auffädelungen, Form des Faserverteilungsdiagrammes, Prozentsatz der Faser unter einer bestimmten Längenklasse, Gruppierung und Regruppierung im Rahmen der Auffädelungen.

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Technische Universität „Gh. Asachi". Jassy, Lehrstuhl für Spinnerei und Weberei

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CERCETĂRI ASUPRA FORȚELOR DE LAMINARE

(Rezumat)

Cercetările proprii privind forțele de laminare au fost indreptate în două direcții: realizarea unui dispozitiv propriu în vederea determinării experimentale a forței de laminare și determinarea mărimii forței de laminare pe laminoare.

Măsurarea forței de laminare în timpul funcționării mașinii s-a efectuat cu ajutorul unui dispozitiv de concepție și realizare originală, iar valorile inregistrate sunt printre puținele valori concrete obținute pe plan mondial.

Cu ajutorul dispozitivului amintit s-a reușit determinarea influenței unor parametri tehnologici (incărcarea trenului de laminat, ecartamentul în spațiu critic, finețea fibrelor, desimea acelor baretelor, avivaj) asupra forței specifice de laminare.

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Secţia VIII
TEXTILE. PIELĂRIE

METHOD FOR DOUBLING THE WIDTH OF THE PANELS KNITTED WITH 1×1 RIB BORDER AND SINGLE JERSEY BODY ON THE AUTOMATIC FLAT KNITTING MACHINES

BY

MIRCEA MATEESCU, STELIAN FILIPESCU and LILIANA TOADERE

The method presented in this paper allows the production on all modern automatic flat knitting machines of panels with 1×1 rib on selected needles border and single jersey body and a yarn crossing zone at one edge of each panel.

This appears the possibility of obtaining intarsia effects, extending the technological possibilities of these machines.

1. General Elements. The last years developments in the field of the automatic flat knitting macines allow the development of a new series of knitting schemes with special technologycal and market effects instead of the clasic schemes.

The method which is presented in this paper can be applied to all the automatic flat knitting machines which have special take-down devices (presser-jacks or presser-foot, take-down sinkers, etc.).

The use of this method has two major advantages, each of them beeing more important than the other depending on the angle of the view pointer:

– if the method is used at flat knitting machines with small width the major advantage is the possibility of knitting garment panels with double width than the garment panels which can be usually knitted on these macines;

– if the method is used at flat knitting machines with medium width (for garments) besides of the above mentioned advantage there is another one: the possibility of knitting some special effects like intarsia on the unspecific machines for intarsia, so developing the technological abillities of these machines.

2. The Method of Doubling the Width of the Knitted Panels. Using this method is knitted in the final stage a panel with border rib 1×1 on the selected needles and a single jersey body, with a zone in which the yarns are twisted, this zone being placed at one of the two selvedge of the knitting width.

In Fig. 1 *a* is represented the position of the two 1×1 rib borders (*1* and *2*) and of the two single jersey bodies (*3* and *4*) with the twisting zone *5*.

In Fig. 1 *b* is shown the form and the position of the two bodies, *1, 3* and *2, 4* linked each other between the twisting zone *5*. It is obvious that the two 1×1 rib borders are not linked together because of their separate knitting.

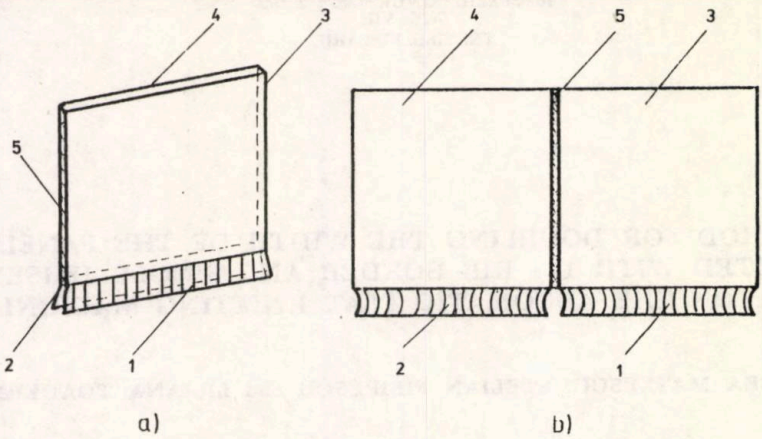

Fig. 1

In Fig. 2 is shown the initial position (in the left edge) of the yarn carriers with the needle bed on which these will feed further the yarns to make the twisted link between those two single jersey bodies only in the left side.

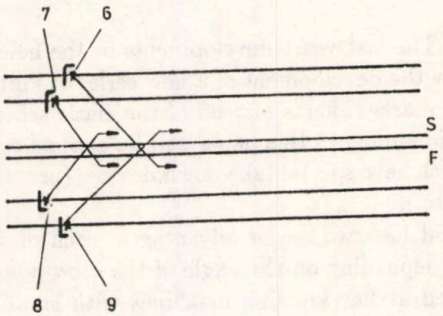

Fig. 2

In Fig. 3 are shown the needle notation system and the yarn carriers moving scheme for the knitting panel.

The two borders are knitted separated in a 1×1 Rib structure on the selected needles, first the courses $R_1 \ldots R_{n+1}$ and then the courses $R'_1 \ldots R'_{n+1}$, then is knitted the single jersey body open at the right edge: $R_{n+2} - R'_{n+2} \ldots R_{n+5} R'_{n+5}$. Fig.3 also shows the twisting zone in the left side which realises the link between the two single jersey bodies each of them knitted on other needle bed.

3. The Needle Notation System and the Yarn Carrier's Scheme for the Knitting of the Panel. The courses presented in Fig. 3 have the following explanation: R_1 – the front needle bed half racking and the forming of the tucks on the neddles *1, 3, 5...* of the front bed and on the needles *2, 4, 6...* of the rear bed; R_2 – knitting on the needles *1, 3, 5...* of the front bed; R_3 – knitting on the needles

2, 4, 6... of the rear bed; $R_4 - R_n$ – knitting of the first border in 1×1 Rib structure on the selected needles.

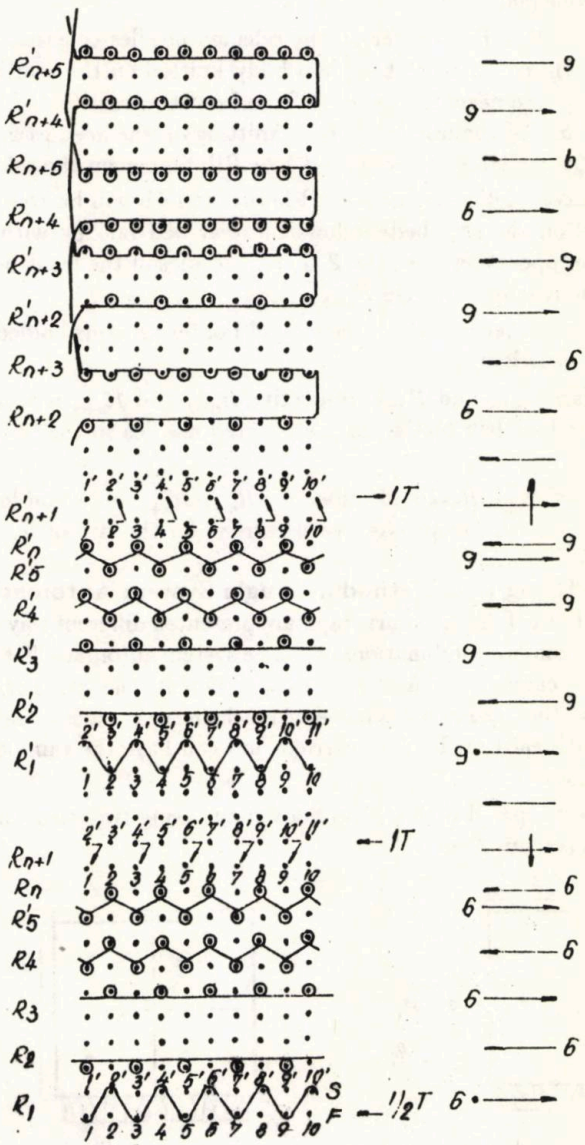

Fig. 3

After the knitting of the first border (which will be continued with plain knit on the front bed) the rear bed is racked one step to the left and is made a transfer phase

the loops in the needles *2, 4, 6...* of the rear bed are transfered to the needles *1, 3, 5...* of the front bed (Course R_{n+1}).

After this transfer operation the first border remains holded by the needles *1, 3, 5...* of the front bed.

The second 1×1 Rib border on the selected needles consists of courses $R'_1 \ldots R'_n$. This border will continue with a plain body knitted on the rear bed: R'_1 – forming of the tucks on the needles *2, 4, 6...* of the front and rear bed; R'_2 – knitting on the needles *2, 4, 6...* of the front bed; R'_3 – knitting on the needles *2, 4, 6...* of the rear bed; $R'_4 - R'_n$ – knitting of the second 1×1 Rib border on the selected needles.

After the completion of the second border (which will be continued with a plain body knitted on the rear bed) follows the rear bed racking with one step to right and a transfer operation from the *2, 4, 6...* needles of the front bed to the *2, 4, 6...* needles of the rear bed (course R'_{n+1}).

After this transfer operation the second border remains holded by the needles *1, 3, 5...* of the rear bed.

The courses R_{n+2} and R_{n+3}, respective R'_{n+2} and R'_{n+3} represent the transition zone from the 1×1 Rib border on the selected needles to the full plain body of the panel.

The courses R_{n+4}, R_{n+5} and respective R'_{n+4}, R'_{n+5} and so on form the plain body and are knitted with independent yarn carriers for the two beds.

4. Ways of Using this Method at Single System Automatic Flat Knitting Machines. In the following paragraph are presented different ways of knitting panels with different colours combinations on single system automatic flat knitting machines with 2-4 yarn carriers, using 2-4 yarns of different colours. For each variant it is presented also the yarn carriers movement schemes. At each variant the borders can be knitted with each of the yarn carriers and can have the same colour of the yarn, different coulour:

Fig. 4 shows a panel with a plain body made using two yarn carriers *6* and *9*, and two different colours *A* and *B*.

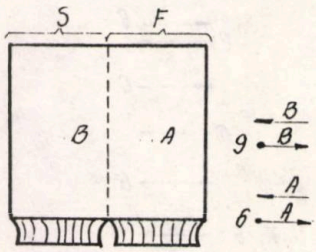

Fig. 4

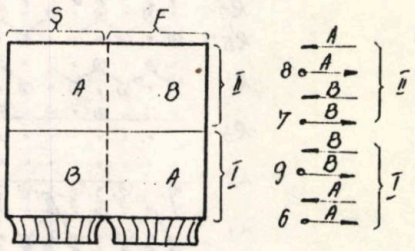

Fig. 5

Figs. 5 and 6 show a plain body made using four yarn carriers *6, 7, 8* and *9*, and two colours *A* and *B*.

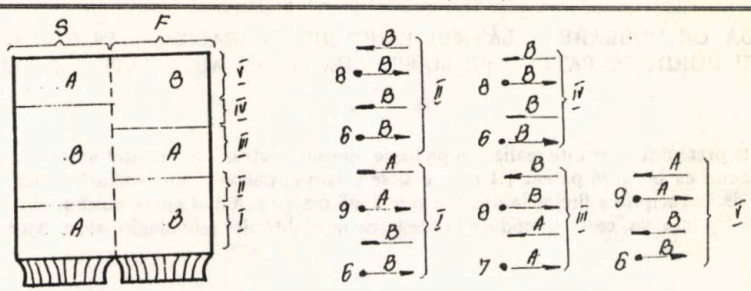

Fig. 6

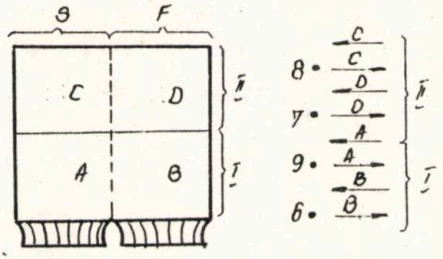

Fig. 7

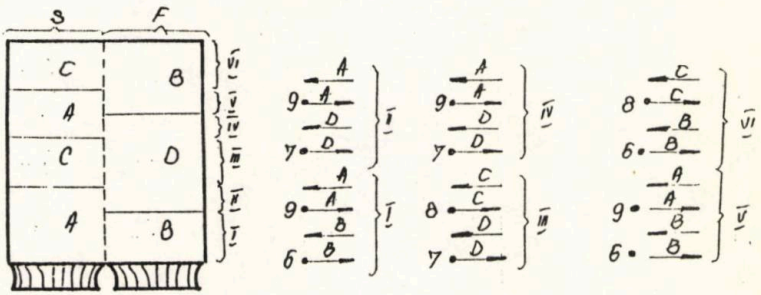

Fig. 8

Figs. 7 and 8 show a plain body made using four yarn carriers *6*, *7*, *8* and *9*, and four different colours *A*, *B*, *C* and *D*.

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Technical University "Gh.Asachi", Jassy,
Department of Knitting and Confections

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METODĂ DE DUBLARE A LĂŢIMII PANOURILOR REALIZATE ÎN STRUCTURĂ GLAT CU BORDURĂ PATENT PE MAŞINI RECTILINII AUTOMATE DE TRICOTAT

(Rezumat)

Metoda prezentată permite realizarea pe toate maşinile rectilinii de tricotat automate moderne a unor panouri cu bordură patent 1:1 pe ace alese şi corpul panoului în structură pe bază de glat cu o zonă de încrucişare a firelor la una din cele două margini. Astfel apare posibilitatea obţinerii unor efecte tip intarsia, ceea ce conduce la creşterea posibilităţilor tehnologice ale acestor maşini.

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Secţia VIII
TEXTILE. PIELĂRIE

PRODUCTION OF KNITTED FABRICS WITH CABLE DESIGNS ON FLAT KNITTING MACHINES

BY

DORIN DAN, LUMINIŢA CIOBANU and M. PENCIUC

In this paper the conditions, the restrictions and the principles for producing knitted fabrics with cables and aran design on automatic flat knitting machines are presented.

1. General Considerations. Knitted fabrics with cable designs have in their structure elements (normal stitches, float stitches, tuck loops) disposed parallel to the wale direction or under a certain angle to this direction. The value of these angles is determined by the structure, the structural parameters and the knitting scheme. Basically, the production of a cable design uses two groups of wales placed in succession that will change position at certain moments. The effect of the cable design can be emphasised by using a different structure for the other parts of the fabric.

The cable designs are obtained on single and double jersey and purl fabrics.

Until recently the fabrics with cable designs were produced manually on flat knitting machines with "V" beds. The cable design can be obtained both on front and rear bed. The last one is preferred due to the possibilities to simplify the operations, the counting of the wales and the removing of various faults that can appear. The transfer and the crossing of the wales (loops) are made with an instrument named "decker" with 1 to 4 transfer needles.

The improvements brought to the knitting machines regarding the stitch transfer, the racking and the programming make possible the production of cable designs on automatic knitting machines. The paper presents some examples of cable designs produced on automatic knitting machines with 1 or 2 systems using methods based on which observations can be made regarding the conditions, restrictions and production principles of these fabrics.

2. Knitting Sequences for Cable Designs. Fig. 1 presents the knitting sequence for a 6×3 double jersey with 2×3 cable design produced on a flat knitting machines with 2 systems. The sequence contains the successive stages of knitting (R1-12), of racking and of transfer from a bed to the other (see sections $a - d$).

The beds are so positioned that the needles are placed one in front of the other. The needles are individually selected for knitting and for transfer.

The group of wales (stitches) that will form cable design are made of wales 1, 2 and 3, respectively 4, 5 and 6 from the front bed. The rear bed racking is of 3 needle

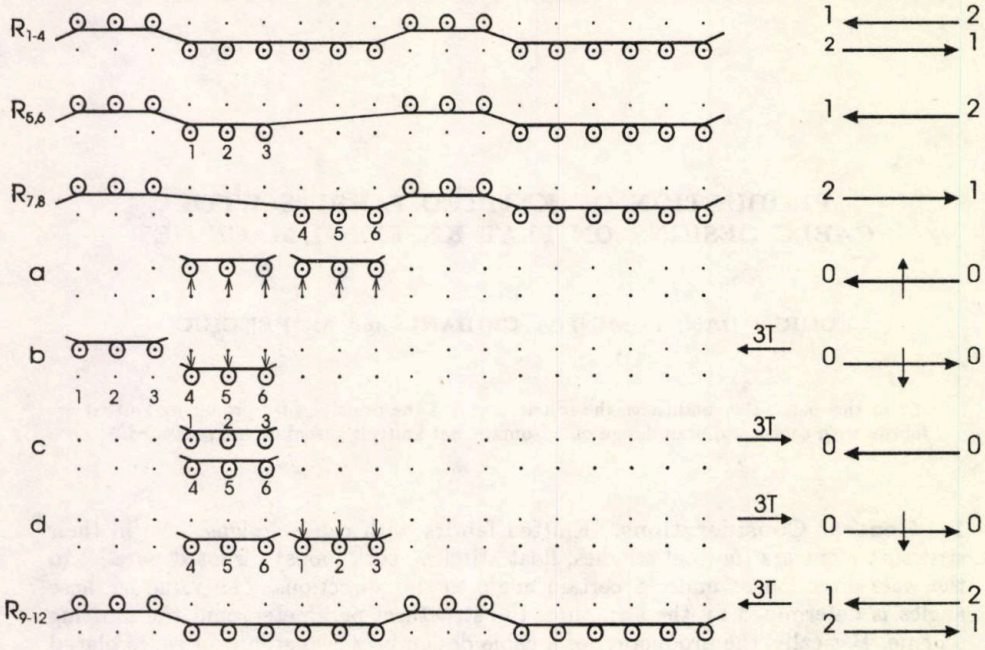

Fig. 1

speces (3T) to the right or to the left.

Fig. 2 illustrates an ARAN design, characterised by wales created on the rear bed that diagonally disposed:

a) one course is knitted with some of the active needles in the front and rear beds. The two active rear bed needles knit the loops of the diagonally moving wales.

b) the two rear loops are transferred to the front bed.

c) the front needle bed is racked one needle space to the right and the rear loop from the right is transferred back on the rear bed, but on a different needle.

d) the front bed is racked two needle spaces to the left and two loops are transferred to the rear bed.

e) the front bed is racked two needle spaces to the right and one loop is transferred to the rear bed.

f) the front bed is racked one needle space to the left and two loops are transferred to the front.

g) one course is knitted. The loops transferred to the rear on stage f are now used as pevious loops for the new knitting cycle, thus generating new stitches. It must be underlined that the rear loops are always knitted on different needles due to the repeted transfers and raching of the rear bed.

Fig. 2 presents only a part of the ARAN design which explains the modus operandi used to obtain the diagonal disposal of the rear wales. The ARAN effect is based on the opposite disposal of two groups of rear wales, generating a diagonal design.

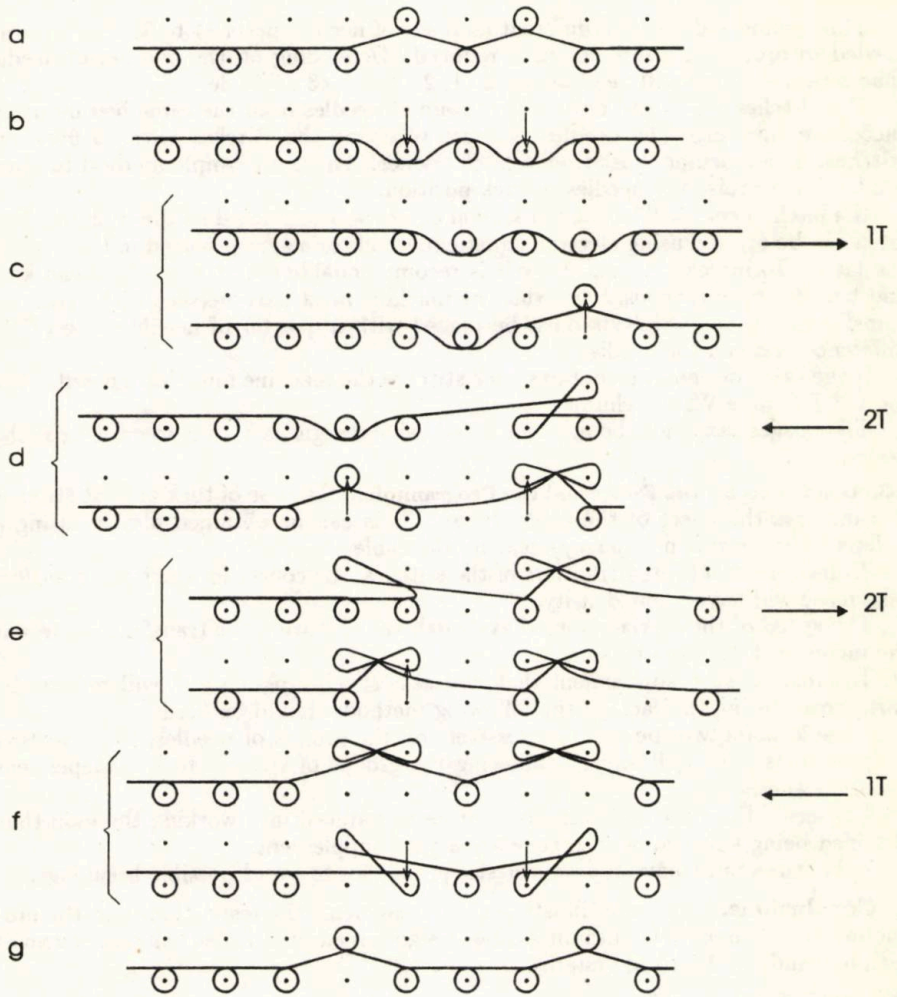

Fig. 2

3. Conditions, Restrictions and Production Principles for Fabrics with Cable Designs. The production of cable designs is influenced by the technological possibilities of the knitting machine that depend mostly on the knitting elements and the cams.

The person that does the programming must know the knitting sequence for the cable design, always considering the reduction of yarn tension during knitting.

3.1. Conditions for the Knitting Machines. To produce cable designs the needles from the front or the rear must have selection possibilities both for knitting and for transfer. The electronic computerised knitting machines can produce such fabrics with different structures in the same course.

The racking is done with different numbers of needle speces (1 to 3). So the time needed to produce a cable design is reduced. Depending on the number of needle spaces racked, there will be obtained 2×1, 2×2 or 2×3 cable designs.

The stitches are placed on another group of needles from the same bed by using successive transfer. The needles that are receiving the stitches have no previous stitches. The machine must have a latch opener. The most simple method to open the latch is to raise the needles to tuck position.

If a latch opener will be used, a special device will command its functioning. The latch can be opened using electromagnetic methods or a spring placed in the knot of the latch. To increase productivity it is recommendable that the machine can knit and transfer simultaneously. For this the machine must have needles with extended transfer spring and the beds must be placed with a quarter of needle space ($T/4$) difference between the needles.

If the cable design also contains tuck stitches the machine must have possibilities for TWT (Three Way Technique).

The guages range for the machines used cable designs is 3 - 8 E to emphasise the design.

3.2. Conditions for the Fabric and the Programming. The use of tuck or float stitches will increase the effect of the cable design. This can be obtained also by using a different structure (single jersey) near by the cable.

To insure the repeated transfers of the stitches, the course in which the transfers take place will have a low density.

The speed of the carriage must have small values during the transfers to prevent the increase of the yarn tension.

To create a yarn supplement that will ease stitch crossing and will reduce the yarn stress during the racking the following methods should be used:

– the knitting will be done successively on the groups of needles, thus creating long floatings (Fig. 1, R5-8) and allowing the groups of stitches to be independent one from another;

– a needle from the opposite bed will be introduced into working the loop thus obtained being knocked over to generate a yarn supplement;

– the yarns must have superior elastic properties to avoid possible breakings.

4. Conclusions. The paper illustrates the conditions, the restrictions and the production principles used in obtaining cable designs on automatic flat knitting machines with one and two knitting systems.

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Technical University "Gh. Asachi", Jassy,
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PRODUCEREA TRICOTURILOR CU ȘIRURI ÎNCRUCIȘATE PE MAȘINI RECTILINII DE TRICOTAT AUTOMATE

(Rezumat)

Sunt prezentate condițiile, restricțiile și principiile pentru producerea tricoturilor cu torsade și desene ARAN pe mașini rectilinii de tricotat automate.

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TEXTILE. PIELĂRIE

METHODS OF PRODUCING SHAPED PANELS ON FLAT KNITTING MACHINES

BY
LUMINIŢA CIOBANU, DORIN DAN and M. PENCIUC

This paper presents a method for producing shaped garmet panels by flat knitting machines in order to obtain saving in yarn.

1. Introduction. The paper presents the methods used to obtain shaped panels on "V" bed flat knitting machines of different types (manual, mechanical or computerised). The purpose of this operation is to reduce the waste of raw material.

2. Analysis of the Present Situation. Nowadays, the companies with flat knitting machines produce the following types of knittings: plane or tubular knittings, panels, shaped panels, "one piece" panels.

To produce these knittings different technological conditions and requirements are necessary regarding the threading, the setting of the stop blocks, the take down mechanism, the use of special devices. The shaping of a panel presumes the variation of the number of active needles and of the carriage's movement.

The take down strength must be adjusted depending on the knitting width. Because of its variation, the take down strength is supposed to be uniformly distributed in all the wales of the panel.

To widen or to narrow of the panels needle selection is required for one or both needle beds.

The special devices needed for shaping are: special device for the take down mechanism, widening devices (VKTM, P_3A, $P_{3A}RT$), counter for the courses in which the shaping is produced, transfer cams.

3. New Working Conditions. Experimental Data. New working conditions are proposed for panel shaping:

– the identification of garments that need both sides widening (ex: pants for children, sleeves, skirts);

– the use of the Romanian knitting machines and all their technological possibilities (VKTM, R11, R12, R50, JAR 201);

– the avoidance of constructive and functional modification of the different mechanisms and devices;

– the maintaining of the carriage's movement at a constant value;

– the maintaining of the same conditions for the yarn tension at the end of the carriage's movement regardless its direction;

– the use of knitted structures that will emphasise the shaping;

– the use of a constant number of working needles.

Fig. 1 presents the working sequence for a panel with windening on both sides used for producing a pair of children pants. The needles have butts of two heights placed in a 1:1 ratio.

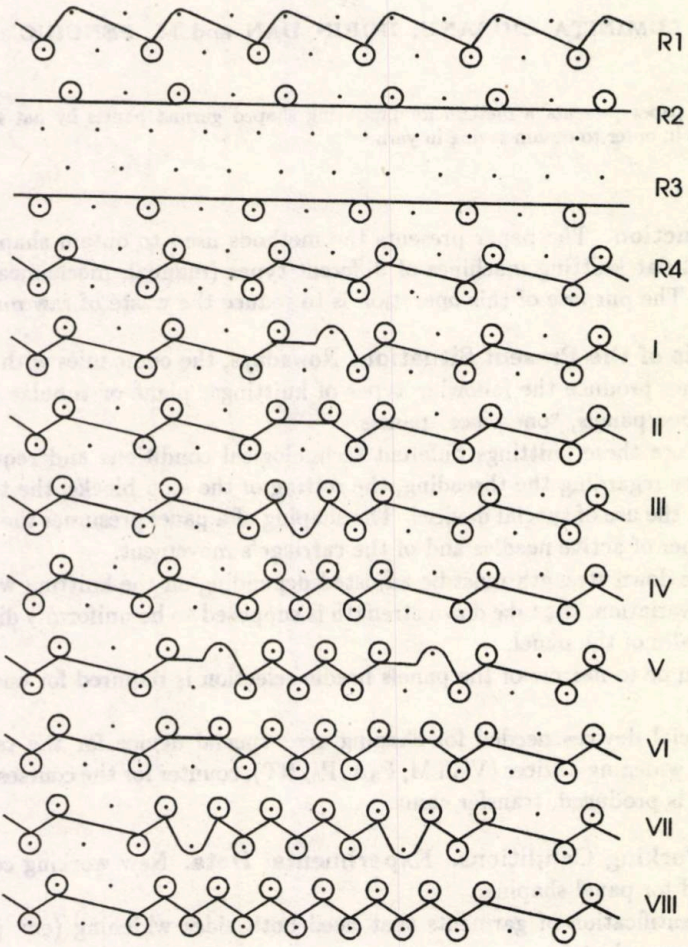

Fig. 1

The knitting starts on half of the needles, the working width being constant through all the panel's length. The shaping is made by introducing in work the needles with a low but "s", starting with the one in the middle.

Fig. 2 presents the form of the shaped panel as described.

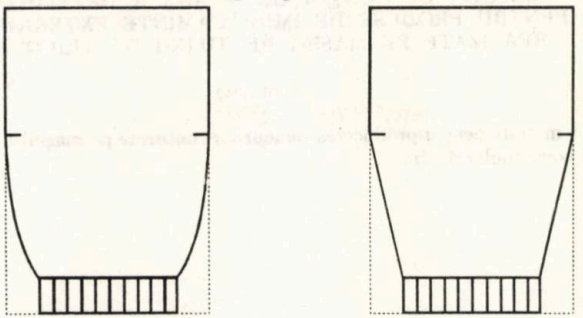

Fig. 2

To begin the widening, the first needle introduced in working is the middle "s" needle from the rear bed. All the working needles will produce stitches. Then the middle "s" needle from the front bed will start working. All the working needles will produce normal stitches. After that, at each two course, one needle is added on each side of the panel. The structure used for the panel is 1×1 rib.

The knitting sequence was tested on a VKTM model (K=5E, Lf=100 cm, S=1) using 100% PAN yarns with a count of Nm 36/2/3.

The quality adjustments were the same for the front and the rear bed. The yarn tension was about 30 cN. The form of the panel was previously designed. The shaped panel was compared to a normal one, and it resulted an economy of 9.7 g/panel.

4. Conclusions. The new shaping method reduces the consumption of raw materials by eliminating the wastes that occur during cutting. Considering a production of 1,000 panels, it results an economy of 9.7 kg of yarns, thus obtaining a plus of 71 garments.

Because the widening starts in the panel's middle, its sides are straight and the sewing can be done along the wales. The new shaping method allows the use of a double thread chain stitch assembly, thus eliminating the disadvantage that results from the cutting of the yarns while sewing.

The technological possibilities of the Romanian machines are to be used to all their extent, no alteration of the mechanisms being necessary.

The method can be used for different garmet products.

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METODĂ DE CONTURARE PLANĂ A DETALIILOR PENTRU PRODUSE DE ÎMBRĂCĂMINTE EXTERIOARĂ REALIZATE PE MAŞINI RECTILINII DE TRICOTAT

(Rezumat)

Se prezintă o metodă pentru producerea panourilor conturate pe maşini rectilinii de tricotat cu scopul reducerii consumului de fire.

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Secţia VIII
TEXTILE. PIELĂRIE

OPTIMIZATION OF THE CONSTRUCTION OF INDIVIDUAL PROTECTION EQUIPMENTS FROM THE POINT OF VIEW OF ERGONOMIC INDICES

BY
EMILIA FILIPESCU and MIHAELA ISPIR

The main function for the individual protection equipments is to ensure the dimensional correspondence of the man-product system both in static and dynamic regime.

The paper presents some theoretical aspects and experimental results concerning the optimization of protection equipment construction.

For the "blouse from the overall man costume", it was applied the algorithm for mathematical modelling which allowed the optimization of construction for this product through establishing the rational values of some additions are useful for dimensioning of certain constructive segments for the basis patterns, which is important to ensure the correspondence between this product and the carrier body at the high level.

1. Introduction. The basis problem of the design of individual protection equipments is the need to reach an optimum in the conditions of hard working activity. The complex solving of this problem implies both assuring efficiency in protection and taking into acount the ergonomic aspects of the product during the functioning of the man-protection environment system.

Among the ergonomic indicators, the anthropometric ones (corresponding with the size and form of the carrier body, with the characteristic working movements) determine in the greatest measure both the solving of the constructive-technological scheme and the principal constructive parameters of the designed product.

In the process of designing individual protection equipments, the problem of dynamic correspondence with the movements at the working place is considered from the position of so-called "comfort(ease)" of the protection equipment, often solved empirical without a substantiation of the construction rationality from an ergonomic point of view, with objective evaluation methods. Thus, the establishment of the relation between ergonomic criteria and constructive parameters of individual protection equipments for a broad range of exploiting conditions is necessary in order to optimize them [1].

The paper presents theoretical aspects and practical results of the optimization of protection equipment construction.

2. The Algorithm for Mathematical Modelling and the Establishment of the Optimization Criteria. Experimental. The blouse from the overall man costume was analysed.

The costume is designed for protection against mechanical agents, for activities with a moderate dynamic and an energy consumption lower than 290 W, and is made by a chemical fiber mixture material (pes+celo).

For the protection coat, the important ergonomic parameters are the parameters of the cut (width and depth of the cut) and the total width of the product at the cut. These parameters are determined by the addition on the bust line and it's repartition on the main zones.

Thus, as independent variables were chosen:

– the repartition share from the basis addition (Ab) for the cut zone, $\%Ab : z_1$ – necessary for the dimensioning of the constructive segments at the level of the bust line;

– the addition for the back cut $A_{ARS} : z_2$ – necessary for the dimensioning of the pattern segment also named "back height";

– the addition for the sleeve width at the cut $A_{lrm} : z_3$ – necessary for the sleeve width dimensioning.

These additions were considered because they appear at the dimensioning of certain constructive segments of the basis patterns. The easy movements of the arms and the limited displacement of the product in relation with the body depend mostly on the above mentioned dimensioning and represent basic conditions in the case of the protection equipments [2].

As a dependent variable, the displacement of the ending line of the product at the rise of the dressed subject's arms, was considered.

The aim of the study was the determination of the values for the three additions, minimizing the ending line displacement with arms movements.

Basis constructions were realised, according to the existent standard STAS 1280-77. All these constructions were practically verrified using the ergonomic screen [3].

The movement of the arms from the down vertical position (α=0°) to the up vertical position, parallel with the body (α=180°) was analysed. For various movement amplitudes (angles), the level of the product ending line displacement was established.

Taking into account the advantages of the active experiment a central compositional rotative programming of the second order was accomplished [4]. The mathematical data processing was performed for an angle between the arm and body directions of 180°.

In Table 1 are presented variation levels of the independent variables.

Table 1

Variation Levels of the Factors

Factor	Symbol	Variation level			Variation interval
		−1	0	+1	
% Ab for the cut zone	x_1	9.5	14.5	19.5	5 (%)
A_{ARS}	x_2	6.6	7.6	8.6	1 (cm)
A_{lrm}	x_3	6.1	7.1	8.1	1 (cm)

x_i represents the encoded value of the z_i factor, calculated on the basis of knowing the basis level z_{i0} and the variation interval Δz_j. The regression equation which establishes the correlation between the dependent variable y and the independent ones x_1, x_2, x_3 has the form:

$$y = b_0 + \sum_{i=1}^{3} b_i x_i + \sum_{\substack{i=1 \\ j=1 \\ i \neq j}}^{3} b_{ij} x_i x_j + \sum_{i=1}^{3} b_{ii} x_i^2, \tag{1}$$

in which: b_0, b_i, b_{ij}, b_{ii} are the coefficients of the regression equation, calculated with the less square method.

In Table 2 a fragment of the central compositional rotative programming of the second order matrix (k=3) is presented.

Table 2

The Central Compositional Rotative Programming of the Second Order Matrix (k=3)

No.	x_0	x_1	x_2	x_3	x_1^2	x_2^2	x_3^2	y_{uexp}	y_{calc}	$(y_u - y_{calc})^2$
1	1	-1	-1	1	+1	1	1	28.5	28.78	0.08
2	1	1	-1	-1	1	1	1	28.7	29.03	0.11
3	1	-1	1	-1	1	1	1	30.45	30.75	0.09
4	1	1	1	1	1	1	1	29.3	29.57	0.08
5	1	-1	-1	-1	1	1	1	29.2	29.49	0.09
6	1	1	-1	1	1	1	1	28	28.31	0.1
7	1	-1	1	1	1	1	1	29.7	30.04	0.12
8	1	1	1	-1	1	1	1	30	30.28	0.08

After the statistical verification of the unlinear model coefficients, the regression equation obtained has the form:

$$(2) \quad y = 28.58 - 0.233x_1 + 0.628x_2 - 0.356x_3 + 0.156x_1^2 + 0.608x_2^2 + 0.192x_3^2.$$

The model concordance was verified with the F i s h e r criteria and it was found that the regresion equation obtained estimates approximately the studied real process.

The x_1 and x_3 factors have positive effect (their growth leads to the decrease of the optimization parameter) while the x_2 factor has negative effect. For determination of the optimum realization conditions, the equation (2) is brought to the canonical form, according to the known methodology [4]. The canonical equation has the form:

$$(3) \quad Y - 28.16 = 0.156X_1^2 + 0.608X_2^2 + 0.192X_3^2.$$

It has been found from the canonical equation that $B_{ii} > 0$ $(i = 1, 2, 3)$, so the searched response area is a rotation ellipsoid. The centre of the figure corresponds with the minimum value of the optimization parameter.

In order to analyse the response area, it was used the method of the binary sections, making one factor constant and varying the other two factors. The response areas are ellipses. In Fig.1 there are presented two response areas:

$$(4) \quad x_1 = 0, \qquad Y - 28.25 = 0.608X_2^2 + 0.192X_3^2,$$

$$(5) \quad x_2 = 0, \qquad Y - 28.32 = 0.156X_2^2 + 0.192X_3^2.$$

3. Conclusions. From the analysis of the regression equation it has been found that all three factors have influence on the analysed variable (x_1 and x_3 factors have positive effect and x_2 negative effect). Depending on the partial conclusions, the minimum estimated value of the optimization parameter is obtained when the x_1 and x_3 variables tend to the maximum value (+1) and x_2 tends to the minimum

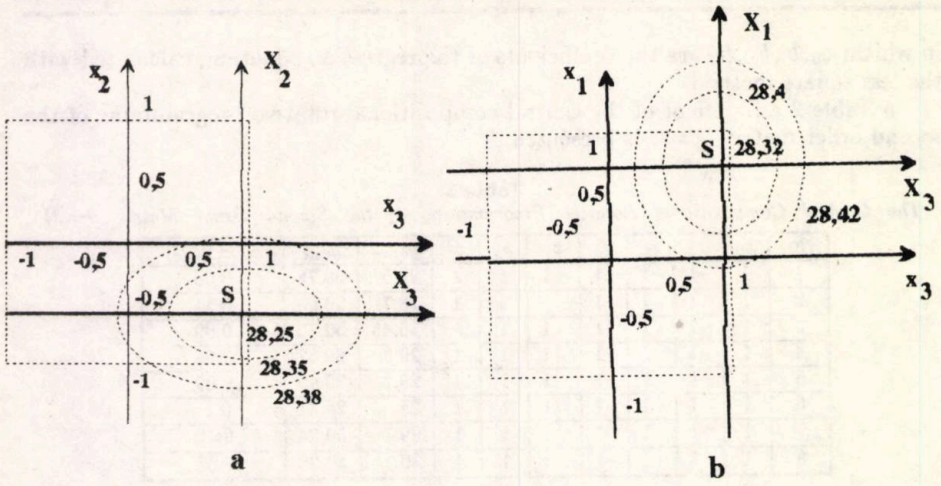

Fig. 1.– Response areas.

value (–1): % Ab=19.5% for the cut zone, A_{lrm}=8.1 cm and A_{ARS}=6.6 cm. From the analysis of the response areas it has been found that y_{min}=28.16 cm (%Ab=19.5%, A_{ARS}=7.1 cm, A_{lrm}=7.5 cm).

The results of this study allow the correct dimensioning of the product. For individual protection equipments are recommended increased sleeve width and cut width. The decreased addition for the depth of back (A_{ARS}) denotes a more stressed covering of the zone between the cervical point to the posterior axillary points, but without pressing the body.

The working methodology which was applied for the blouse from the overall man costume can be used for another types of products with shoulder support. The independent variables can be modified according to the case.

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OPTIMIZAREA CONSTRUCŢIEI ECHIPAMENTELOR INDIVIDUALE DE PROTECŢIE DIN PUNCT DE VEDERE AL INDICATORILOR ERGONOMICI

(Rezumat)

Funcţia principală a echipamentelor individuale este cea de asigurare a corespondenţei dimensionale în regim static şi dinamic a sistemului corp-produs.

Sunt prezentate unele aspecte teoretice şi rezultatele experimentale privind optimizarea construcţiei echipamentelor de protecţie. Pentru produsul „bluză de salopetă pentru bărbaţi" s-a aplicat algoritmul modelării matematice care a permis optimizarea construcţiei acestui produs prin stabilirea valorilor raţionale ale unor adaosuri utile la dimensionarea segmentelor constructive ale tiparului de bază cu efecte în asigurarea la un nivel înalt a corespondenţei acestui produs cu corpul purtătorilor.

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Secţia VIII
TEXTILE. PIELĂRIE

THE MATHEMATICAL MODELLING AND THE GRAPHIC VISUALISATION OF SPATIAL SHAPES

BY

DAN-FLORIN CROITORU, MARIANA COCEA and CORNELIA IONESCU

In this paper we present a method of mathematical modelling and graphic visualisation of spatial shapes by using the B-spline interpolation method of 3D outlines.

The graphic visualisation of shapes, allow the user to obtain suggestive images. They are suggestive not only for promoting new footwear products, but also for a 3D casting.

1. Introduction. The plotting is the most powerful and pliant way of communication between computers and the human being.

Objects, photos, sketches as well as texts (lines of letters and numbers) can be perceived, but the interpretation of graphic information is faster than understanding a text. This is because it's easier for the brain to perceive images than letters and numbers.

The development of calculation technique and the appearance of powerful computers allowed us to obtain, in CAD, some images that the user can't tell if they are photos or drawings.

2. Studies Regarding the Mathematical Modelling and the Graphic Visualisation of the Spatial Shapes. The graphic visualisation of shapes on the computer's display actually means methods of introduction, processing and the information's extraction within the framework of specialised algorithms. The obtained image must respect not only a result of the tackled method, but also a mathematical modelling of the geometrical model [1].

The mathematical modelling of the shapes establishes the object's numerical shape by means of some interpolation methods.

For that, points are picked from the shape's surface or from near by, in a $xOyz$ axis system. These points belong to some cross or longitudinal sections, and/or cross, longitudinal sections.

The points are joined with lines or curve arcs to obtain suggestive representations of the object.

Mathematical modelling and graphic visualisation assume the next major charges:

– establishing the method of mathematical modelling and graphic visualisation;

– defining the numerical model of the body's geometry depending on the chosen

method;

– creating data massifs, in the shape of files, with the points' coordinates that define the body's geometry;

– elaborating a union algorithm of the points that define the body's geometry through lines or curves. In the last case it is necessary to use an algorithm to generate the curves or the 3D areas through interpolation methods [2];

– elaborating an algorithm to transform the numerical and spatial shape of the object (3 co-ordinates points) into 2 co-ordinates points on the computer's screen. The obtained image must be perceived by the user as a spatial shape [3].

3. Results. In this paper we studied the modelling of the curves and the 3D areas with our own algorithms.

In the first part of the paper we studied possibilities of modelling 3D curves defined through cross sections.

The sections are marquee through planes that are perpendicular on the Oz axis. By joining the points with lines, the obtained images are only polygons (Figs. 1, 2).

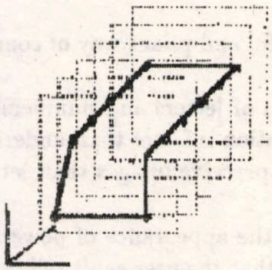

Fig. 1

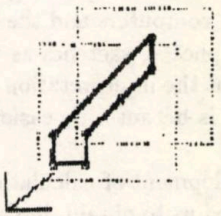

Fig. 2

By applying the interpolation method with B-spline functions, we obtained smooth curves, without discontinue (Figs. 3, 4). This allowed the mathematical modelling of a 3D object.

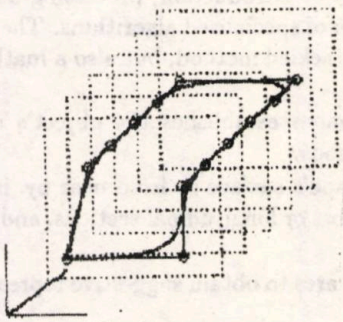

Fig. 3

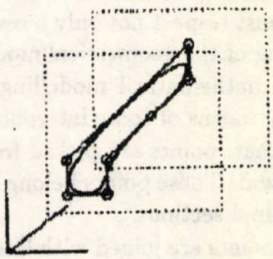

Fig. 4

In the second part of the paper we elaborated an algorithm of mathematical modelling and graphic visualisation of a last (Fig. 5).

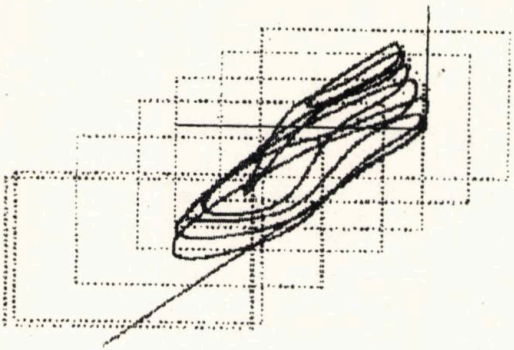

Fig. 5

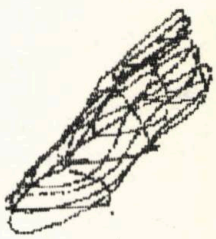

Fig. 6

In the picture, the shape of the last is defined by longitudinal sections whose points are joined with 3D curves. The points are interpolated by the B-spline method [3]. The achieved image is suggestive (Fig. 6). It can be understood not only by footwear specialists, but also by any computer user.

4. Conclusions

1° Graphic visualisation assisted by computer materialises through suggestive images that can be easily understood by any user.

2° The methods we used allow the casting of footwear products straight on the last.

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MODELAREA MATEMATICĂ ŞI REALIZAREA GRAFICĂ A FORMELOR SPAŢIALE

(Rezumat)

Se prezintă o metodă de modelare matematică şi vizualizare grafică a formelor spaţiale utilizând metoda de interpolare cu funcţii B-spline. Vizualizarea grafică a formelor conduce la obţinerea unor imagini sugestive ce permit promovarea de produse noi în ritmul cerinţelor economiei de piaţă.

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TEXTILE. PIELĂRIE

CONTRIBUTIONS À LA PROJECTION DES CAVITÉS VERSATILES DES MATRICES POUR SEMELLES À L'AIDE DE L'ORDINATEUR

PAR
CORNELIA IONESCU et MARIANA COCEA

Dans le travail on présente une méthode et un algorythme de projection des moules d'exécution des cavités des matrices pour les semelles. Les moules obtenus ont une grande précision et une grande variété de modèles.

1. Introduction. Les semelles se présentent dans une vaste diversité de modèles, détérmines par le type de chaussure, la destination, la forme de l'embauchoir, le volume et l'épaiseur de le semelle, la forme de la trépointe, le modèle du relief antidérapant.

Les semelles qu'on assemble sur un embauchoir d'un certain modèle et à destination particulière avoir, à leur tour, des formes et des volumes diverses. Trouver des modèles aussi nombreux que possible est un problème qui peut être résolu par un programme pour ordinateur.

Dans l'industrie de chaussures, les semelles obtenues comme semi-ouvrées ou directement sur les chaussures, dans la cavité des matrices, detiennent le poids majeur.

Dans ce travail, on va présenter une solution de projection à l'aide de l'ordinateur des multiples cavités de matrices destinées à l'obtention des semelles.

2. Présentation de la méthode. La cavité diversifiée de la matrice est obtenue en parcourant les étapes suivantes [1]:

– l'introduction des contours de base de l'embauchoir;

– la majoration des contours avec les dimensions conformes à l'épaisseur des détails qui composant les faces de la chaussure;

– la projection de la forme des semelles au volume minimum et maximum;

– l'obtention des modèles intermédiaires de la cavité, respectivement des semelles, comprises entre les deux volumes restrictives;

– l'obtention des embauchoirs pour réaliser la cavité de la matrice pour le modèle selectionné.

2.1. L'introduction des contours de l'embauchoir. On introduit les contours du moule par des coordonnées; à cette fin, aux contours de base: le contour longitudinal tracé par l'axe de l'embauchoir, le contour transversal par le centre du talon, le contour de

la projection de la surface plantaire, on attache des systèmes d'axes de coordonnées, comme on voit dans la Fig. 1, pour déterminer la valeur des coordonnées d'un nombre de points qui permette le tracement des courbes.

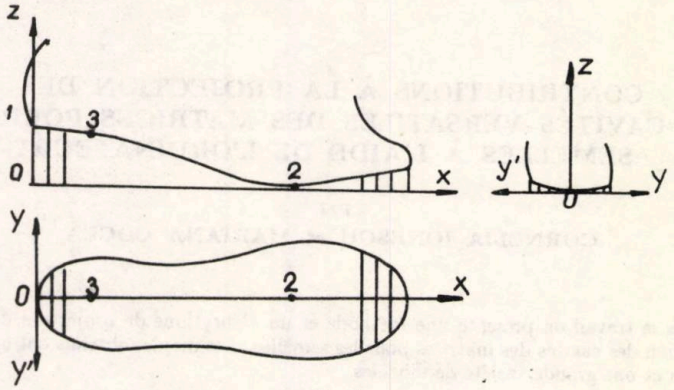

Fig. 1

2.2. Le recouvrage de l'embauchoir avec les faces de la chaussure. On détermine la some de l'épaisseur des faces, on délimite les sones à épaisseur constante et puis on trace des parallèles au contour de l'embauchoir, comme on voit dans la Fig. 2.

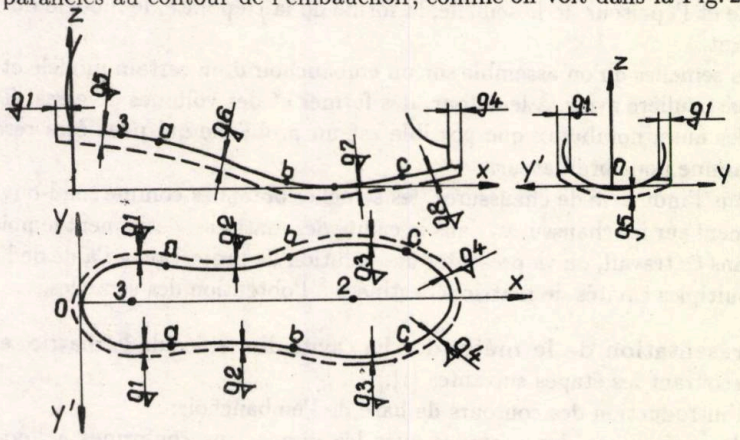

Fig. 2

2.3. La projection des semelles aux formes et dimensions minimales et maximales qui peuvent être obtenues dans la matrice. Dans la Fig. 3 on a représenté les contours correspondant aux dimensions minimales et maximales des semelles qui peuvent être obtenues dans des matrices.

La semelle aux dimensions minimales représentée par la ligne continue, dans cette figure, a la surface du becquet projetée de sorte qu'elle circonscrive le centre du talon, le point *3*, et qu'elle ait une surface d'appui d'au moins de 100 mm^2 dans le but d'assurer un equilibre minimal du corps; la ligne antérieure du talon est droite.

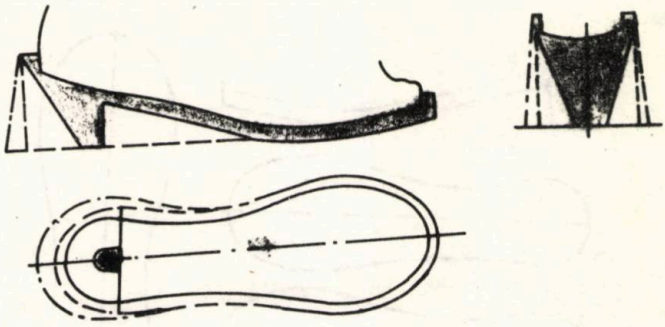

Fig. 3

Les semelles aux dimensions maximales, la semelle ortopédique au contour lateral du talon droit et la semelle ortopédique au contour latéral du talon évasé, ont été représentées dans cette figure par une ligne interromue et ligne-point.

Les trois formes de la semelle établies comme limitatives ont pour variables communes: l'épaisseur de la semelle, la hauteur et la largeur de la trépoint, la forme de la génératrice du bord latéral du talon (droite, convexe, ou concave).

2.4. La majoration des contours en appliquant l'indice de contraction. Les mélanges dont on forme les semelles par refroidissement se contractent, c'est pourquoi la cavité de la matrice doit avoir des dimensions majorées par rapport aux dimensions finales de la semelle, ayant une valeur déterminée par la grandeur du coefficient de contraction du mélange. Les majorations seront appliquées autant dans le sens longitudinal que dans le sens transversal pour les projections en plan orizontal des trois semelles établies comme restrictives, s'ensuivant les corélations dimensionnelles pour la section longitudinale et pour celle transversale aussi.

2.5. L'obtention des modèles des semelles. Entre les contours qui délimitent les dimensions minimales et maximales de la cavité on peut tracer une infinité de modèles de semelles: des semelles aux génératrices droites ou des combinaisons de génératrices droites, concaves et convexes.

Dans la Fig. 4 on a représenté quelques possibilités de tracement des génératrices, en obtenant par la suite, selon le programme, n modèles de semelles qui seront successivement affichées sur le moniteur.

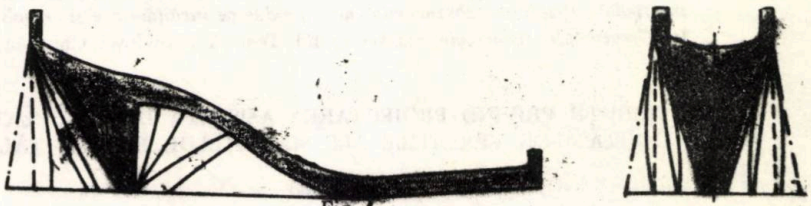

Fig. 4

2.6. L'obtention des moules d'exécution de la cavité. On choisit le modèle de semelle pour lequel on va exécuter la matrice et on extrait sur l'imprimante les moules

d'exécution de la cavité, a l'échelle de 1:1; dans la Fig. 5 on a représenté un serie de tels moules.

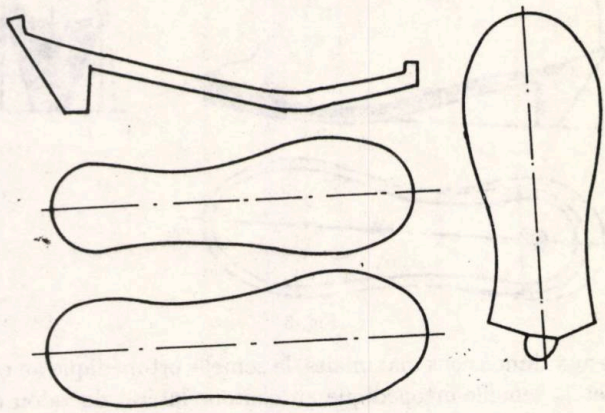

Fig. 5

On fait la précision que dans ce programme on n'a pas prévu l'obtention du contour longitudinal intérieur et extérieur de la cavité, celui-ci étant déterminé par la suite par la méthode classique à l'aide du programme élaboré on obtient le contour longitudinal tracé par l'axe de l'embouchoir.

3. Conclusions.

a) La projection de la cavité et respectivement des moules d'exécution est faite avec beaucoup de précision.

b) La méthode présente l'avantage d'une projection rapide d'un nombre très grand de modèles de semelles et de moules d'exécution des cavités, autant pour les matrices dans lesquelles on forme les semelles comme semi-ouvrées que pour les matrices dans lesquelles on forme les semelles directement sur les faces.

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Chaire de Confections du Cuir

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CONTRIBUŢII PRIVIND PROIECTAREA ASISTATĂ DE CALCULATOR A CAVITĂŢILOR VERSATILE ALE MATRIŢELOR PENTRU TĂLPI

(Rezumat)

Se prezintă o metodă şi un algoritm de proiectare a şabloanelor de execuţie a cavităţilor matriţelor pentru tălpi de încălţăminte. Şabloanele obţinute sunt de mare precizie şi într-o mare diversitate de modele.

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Secţia VIII
TEXTILE. PIELĂRIE

CONTRIBUTION À LA PROJECTION SPATIALE DE LA CAVITÉ DES MATRICES DANS LESQUELLES ON OBTIENT DES SEMELLES ET DES TALONS

PAR

MARIANA COCEA et CORNELIA IONESCU

Dans le travail on présente une méthode de modelage mathématique en espace tridimensionnel des produits pour chaussures (semelles, talons) et des dispositis (matrices).

1. La nécessité du modelage spatial dans l'industrie de chaussures. L'assurance de la compétitivité des produits dans les conditions de concurrence du marché, impose des efforts augmentés aux producteurs roumains de chaussures, à cause du manque des possibilités de promotion des nouveaux produits a l'aide de la technique de calcul.

Cet incovénient peut être aisément résolu, en présentant les nouveaux produits à l'aide de l'ordinateur, en se servant de ses possibilités de projection tridimensionnelle et de visualisation graphique spatiale.

Il y a au moins trois raisons pour utiliser la projection tridimensionelle [1]: un modèle spatial permet la compréhension facile de la manière dont le produit a été conçu et de la façon dont il fonctionne, même par des personnes non initiées dans le domaine; le modèle présenté dans l'espace est une aide importante pour celui qui fai le projet du produit; il facilite une projection correcte et élimine les erreurs.

À la Chaire de Confections en Cuir de l'Université Technique „Gh.Asachi" de Jassy, il y a des préoccupations concernant le modelage mathématique spatiale des corps.

2. Le modelage spatial et la représentation des dessins. On peut obtenir l'image spatiale d'un corps et son modelage mathématique à l'aide de l'ordinateur, en trouvant une forme de codification numérique de la géometrie du corps pour fournir toutes les données nécessaires.

Généralement, on introduit dans l'ordinateur une image, sous la forme d'une série de chiffres et de caractères stockées dans la mémoire externe de l'ordinateur.

Dans la littérature de spécialité [2] on traite plusieures méthodes de modélage: par des points; par des lignes et des courbes; par des facettes planes ou courbes; utilisant des modèles élémentaires qui, joints, suggérents l'image spatiale de l'object.

Pour le modelage correct d'un corps spatial on doit toujours choisir convenablement une multitude de points situés sur sa surface ou dans son voisinage immédiat et

puis les recueillir dans un système de coordonnées imposé ou choisi par l'utilisateur. Bien que la phase d'introduction des données soit difficile, le modele obtenu permettra immédiatement de visualiser le résultat des hypothese et d'introduire rapidement les changements désirés et ainsi, parcourir plusieurs cycles de fabrication.

3. Le modelage mathématique de la semelle en espace tridimensionnel. Les résultats obtenus. À l'aide des logiciels spécialisés présentées dans des travaux de spécialisté [3], [4] on a obtenu le modèle mathématique de la semelle dans le plan.

Dans ce travail on présente une méthode de modelage spatial des talons, des semelles, et des cavités des matrices.

À cette fin on a crée une interface avec le système de projection-dessin AutoCAD, qui constitue un instrument précis, flexible, aux possibilitées multiples de visualisation des corps tridimensionnel.

Parmi les multiples possibilités de l'utilisateur AutoCAD, on s'est servi de: la visualisation des corps tridimensionneles; le modelage d'un corps en reprenant une surface et on lui associant une grosseur.

On a considéré que ces opportunités permettent une visualisation nette d'un talon, d'une semelle, de la cavité d'une matrice.

En reprenant les modèles mathématiques des contours plans de la cavité dans les trois vues de la Fig. 1 et en appliquant la méthode présentée, on a obtenu des images spatials suggestives de la semelle comme on voit dans la Fig. 2 du talon comme dans la Fig. 3 et de la cavité de la matrice, comme dans les Figs. 4 et 5.

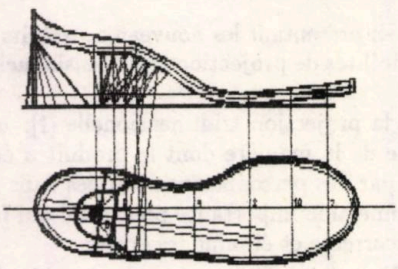

Fig. 1

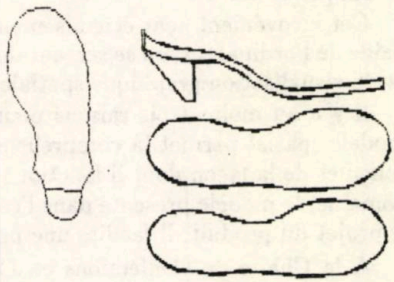

Fig. 2

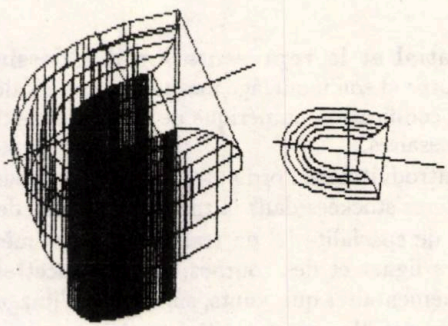

Fig. 3

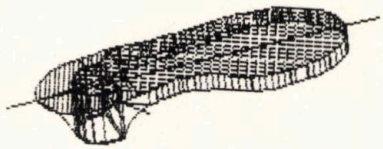

Fig. 4

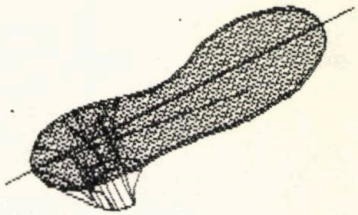

Fig. 5

4. Conclusions.

a) Ce travail constitue une novelle tentative dans la projection assistée par l'ordinateur de produits pour chassures.

b) La visualisation graphique des semelles, des talons, de la cavité de la matrice, en espace tridimensionnel, représente des images suggestive aurant pour l'activité de promotion de ces produits que pour l'activité de projection.

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CONTRIBUŢII LA PROIECTAREA SPAŢIALĂ A CAVITĂŢII MATRIŢEI ÎN CARE SE OBŢIN TĂLPI ŞI TOCURI

(Rezumat)

Se prezintă o metodă de modelare matematică, în spaţiu tridimensional, a unor produse de încălţăminte (tălpi, tocuri) şi a dispozitivelor (matriţe).

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Secţia VIII
TEXTILE. PIELĂRIE

MATHEMATICAL MODELLING OF THE ALKALINE TREATMENTS OF THE PET FIBERS

BY

AURELIA GRIGORIU, CARMEN-ELENA PEPTU, ADRIANA GRECU and ELENA CÎDU

The PET fibers hydrolysis can be studied using a mathematical model of a composed central rotational type, getting more information about the optimal parameters according to the technological, ecological and economical requirements

1. Introduction. All the studies in the literature prove the phenomenon complexity of alkaline hydrolysis of polyesteric polymer powder, fibers, sheets and many factors dependent on the substratum and on the treatment conditions are involved in this process [1],...,[5].

To estimate contribution of three of the most important parameters of the treatment in a discontinuous process (the concentrations of the alkaline solution, the temperature and the treatment time) to the integrity of the polyesteric, fixed and unfixed fabrics – a mathematical model was used, which permitted to discover some aspects of the process of alkaline hydrolysis of PET and a statistical interpretation of the interactions of the parameters.

This study purposed the problem of the integrity of the textile substratum and further research will get thoroughly into technological effects of the treatment (touch, electrostatic charge, draping, dyeing behaviour etc.).

2. Experimental. Experimental attempts were made on polyesteric fabric "Emilia" article, in two variants:

A. Emilia nonfixed article;

B. Emilia article fixed, in the following conditions: T=170-180°C, V=20 m/min.

Experiments were made with a high pressure dyeing LINITEST aparatus or with water baths, temperature being strictly controlled.

Mass losses were estimated by sample weighing before and after the treatment, using an analytical balance.

Breaking resistance and elongation were measured on standardized stripes (30×5 cm) using a TEBA – Timişoara dynamometer in the following conditions; time of trying the resistance to braking =30±5 s; every value is the mean of five measurements.

To model the process of the PET treatment in a discontinuous regime it was used a composed central rotable program with three independent variables: X_1 – concentration of sodium hydroxide (g/l); X_2 – time (min); X_3 – temperature (°C).

The domain of variation for independent variables was the following: the concentration of sodium hydroxide from 20 to 60%, time from 15 to 75 min, temperature from 30 to 120°C.

As purpose functions were chosen: mass loss (%), (Y_1); breaking resistance (N), (Y_2), (Y_3); breaking elongation (%), (Y_4), (Y_5).

3. Results and Discussions. Experimental results (Tables 1,2) were processed by a personal computer using an adequate program. Purpose functions were considered to be second grade polynomials with three variables as following.

Table 1
Purpose functions for A-variant

	Mass loss	Breaking resistance, [N]		Breaking elongation, [%]	
	%	warp	weft	warp	weft
1	0.1587	610	510	28	25.5
2	1.3187	530	500	26	24.5
3	1.2534	600	470	32.5	22.5
4	2.9179	510	500	30	23
5	3.9121	580	480	27.5	25
6	2.4319	580	460	29	23
7	2.8927	560	480	27	24.5
8	6.8719	500	420	30	22.5
9	1.3605	600	500	28.5	23
10	2.1468	530	440	27.5	23.5
11	1.5434	560	480	27	25
12	1.9401	580	420	28	22.5
13	1.1597	620	520	30.5	25
14	4.7953	490	410	25.3	21.5
15	1.6411	554	456	31	22.8
16	1.6435	553	452	31.5	22.4
17	1.6524	550	435	31.2	22.5
18	1.6487	552	452	31.4	22.7
19	1.6454	551	454	31.3	22.6
20	1.6492	555	453	31.2	22.7

A-variant for nonfixed article:

1° Mass loss, [%]

$$\begin{aligned} Y_1 = 1.629 + \; & 0.4866X_1 + 0.4965X_2 + 1.2136X_3 + 0.15X_1^2 + \\ + \; & 0.1485X_2^2 + 0.5828X_3^2 + 0.7454X_1X_2 - 0.0407X_1X_3 + \\ + \; & 0.0908X_2X_3; \end{aligned}$$

2° Breaking resistance in warp direction

$$\begin{aligned} Y_2 = 552.868 - \; & 2.5463X_1 - 0.7556X_2 - 1.8205X_3 + 0.3253X_1^2 + 0.5022X_2^2 - \\ - \; & 0.0283X_3^2 - 0.875X_1X_2 + 1.3749X_1X_3 - 0.875X_2X_3; \end{aligned}$$

Table 2
Purpose functions for B-variant

	Mass loss	Breaking resistance, [N]		Breaking elongation, [%]	
	%	warp	weft	warp	weft
1	0.5274	630	430	29	25.9
2	1.1588	600	410	25	24.8
3	1.1016	620	400	25	23
4	2.1944	610	400	26	23.8
5	2.7293	630	370	26	23
6	6.6923	460	440	22	23.5
7	3.6424	500	350	23	22.5
8	6.4373	526	366	23	22.5
9	1.2911	560	380	24.5	23
10	1.4509	460	360	21	22.0
11	1.3762	600	400	25.5	26
12	1.2679	500	350	22	21
13	0.1559	570	400	24	23
14	4.7425	530	360	20	21
15	0.8154	540	370	23	22.1
16	0.8163	548	370	23.7	22
17	0.8172	543	370	23.5	22.4
18	0.8184	546	370	23.4	22.3
19	0.8159	542	370	23.8	22
20	0.8167	547	370	23.9	22.1

3° Breaking resistance in weft direction

$$Y_3 = 452.396 - 1.1784X_1 - 1.3248X_2 - 0.238X_3 + 0.9985X_1^2 + 0.2212X_2^2 + 0.7516X_3^2 - 1.25X_1X_3;$$

4° Breaking elongation in warp direction

$$Y_4 = 31.2225 - 0.1232X_1 + 0.7821X_2 - 0.8602X_3 - 0.9075X_1^2 - 0.0843X_2^2 - 0.9428X_3^2 + 0.1249X_1X_2 + 1.1249X_1X_3 - X_2X_3;$$

5° Breaking elongation in weft direction

$$Y_5 = 22.599 - 0.286X_1 - 0.7107X_2 - 0.4677X_3 + 0.2994X_1^2 + 0.4762X_2^2 + 0.2994X_3^2 + 0.1874X_1X_2 - 0.4375X_1X_3 + 0.4374X_2X_3.$$

B-variant for fixed article:
1° Mass loss, [%]

$$Y_1' = 0.7745 + 0.6407X_1 + 0.1527X_2 + 1.628X_3 - 0.4687X_1^2 + 0.4514X_2^2 + 0.85X_3^2 - 0.0884X_1X_2 + 0.6292X_1X_3 - 0.119X_2X_3;$$

2° Breaking resistance in warp direction

$$Y_2' = 543.05 - 2.579X_1 - 1.7X_2 - 3.0116X_3 - 0.4536X_1^2 + 0.9609X_2^2 + 0.9609X_3^2 - 2.699X_1X_2 - 1.3X_1X_3 - 0.8X_2X_3;$$

3° Breaking resistance in weft direction

$$Y_3' = 369.251 + 0.2369X_1 - 1.5971X_2 - 1.3275X_3 + 0.4349X_1^2 + 0.6117X_2^2 + 0.7886X_3^2 - 0.4251X_1X_2 + 1.3249X_1X_3 - 0.6751X_2X_3;$$

4° Breaking elongation in warp direction

$$Y_4' = 23.4772 - 0.9437X_1 - 0.7972X_2 - 1.2982X_3 + 0.1593X_1^2 + 0.5129X_2^2 - 0.106X_3^2 + 1.1249X_1X_2 - 0.125X_1X_3 - 0.1249X_2X_3;$$

5° Breaking elongation in weft direction

$$Y_5' = 22.1147 - 0.108X_1 - 1.0113X_2 - 0.6857X_3 + 0.3214X_1^2 + 0.6751X_2^2 + 0.1446X_3^2 + 0.1446X_1X_2 + 0.1X_1X_3 + 0.3X_2X_3.$$

The response areas are elliptical and hyperbolical, so the model set forwards was correctly chosen.

There are differences of the parameter values between A- and B-variants, differences that create the same effect, so the fixed fiber needs stronger treatments (higher concentrations, temperatures times) in order to suffer the same modification.

Table 3

Choice of the optimal domain of the parameters variation for A-variant

No.	Codified range	Real range
1.	$X_1 = -1$	C=28 g/l
	$X_2 \in (-0.8 \div -0.6)$	$t = (30.4 \div 32.8)$ min
	$X_3 \in (-1.4 \div -0.2)$	$T = (36.3 \div 69.6)$°C
2.	$X_2 = -1$	t=27 min
	$X_1 \in (-0.8 \div 1)$	$C = (30.17 \div 52)$ g/l
	$X_3 \in (-1.4 \div -0.2)$	$T = (48 \div 69.6)$°C
3.	$X_3 = -1$	T=48°C
	$X_1 \in (-1 \div -0)$	$C = (28 \div 40)$ g/l
	$X_2 \in (-1 \div -0.6)$	$t = (27 \div 34.2)$ min
4.	$X_1 = 0$	C=40 g/l
	$X_2 \in (-1.2 \div -0)$	$t = (22.88 \div 45)$ min
	$X_3 \in (-1 \div -0.2)$	$T = (18 \div 69.47)$°C
5.	$X_2 = 0$	t=45 min
	$X_1 \in (-1.6 \div 0)$	$C = (20 \div 40)$ g/l
	$X_3 \in (-1.4 \div -0.2)$	$T = (36.3 \div 69.5)$°C
6.	$X_3 = 0$	T=75°C
	$X_1 \in (-1.6 \div 0.6)$	$C = (20 \div 47.4)$ g/l
	$X_2 \in (-1 \div 1)$	$t = (27 \div 63)$ min

For a statistical apreciation of the optimal variation domain of the parameters one can select intervals that satisfy certain demands, for instance:

- a lower than 1% mass loss;
- breaking force and elongation must not be considerably diminished;
- if there are wanted low concentrations of alkalies, low-priced and ensuring environmental protection, high temperature and time values will be used;

– if high concentrations alkalies are considered, the energy consumption will be reduced using low temperature and time values.

On the basis of these requirements one can choose the optimum range for the considered parameters.

Tables 3 and 4 show the optimal domains for A- and B-variants.

Table 4

Choice of the optimal domain of the parameters variation for B-variant

No.	Codified range	Real range
1.	$X_1 = -1$ $X_2 \in (-1 \div 0.8)$ $X_3 \in (0 \div 0.4)$	C=28 g/l $t = (27 \div 59.7)$ min $T = (75 \div 86.05)$°C
2.	$X_2 = -1$ $X_1 \in (-1.6 \div 1.2)$ $X_3 \in (-1.6 \div 0)$	t=27 min $C = (20 \div 54.74)$ g/l $T = (30 \div 75)$°C
3.	$X_3 = -1$ $X_1 \in (-1.4 \div 1.4)$ $X_2 \in (-1.4 \div -0.6)$	T=48°C $C = (22.8 \div 57.2)$ g/l $t = (19.2 \div 33.9)$ min
4.	$X_1 = 0$ $X_2 \in (-1 \div 1)$ $X_3 \in (-1 \div 1)$	C=40 g/l $t = (27 \div 63)$ min $T = (48 \div 102)$°C
5.	$X_2 = 0$ $X_1 \in (-1.2 \div 1)$ $X_3 \in (-1.6 \div 0.2)$	t=45 min $C = (22.88 \div 63)$ g/l $T = (30 \div 80.5)$°C
6.	$X_3 = 0$ $X_1 \in (-1.2 \div 0.2)$ $X_2 \in (-0.6 \div 0.8)$	T=75°C $C = (22.88 \div 42.4)$ g/l $t = (33.9 \div 59.7)$ min

4. Conclusions. The process of PET hydrolysis can be studied using a mathematical model of a composed central rotational type, getting more information from small number of experiments (20 for three independent variables).

The domain for the independent variables previously selected according to the data of literature was correctly chosen, this fact being proved by the shape of the response areas that indicates, most of the times the center of the domain.

From mathematical study we can select optimal parameters according to the technological demands (hidrophily, thouch, electrostatic charge, crease resistance, anti-soil capacity), ecological demands (low mass loss, low alkalies consumption), and economical demands (low time and temperature that imply a low energy consumption).

The future of the saponification technology is uncertain; to the economical disadvantages oppose microfibers as a symbol of quality and functionality, the winner of this contest is difficult to estimate now.

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MODELAREA MATEMATICĂ A TRATAMENTELOR ALCALINE ALE FIBRELOR POLIETILENTEREFTALICE

(Rezumat)

Se prezintă un model matematic pentru tratarea alcalină a ţesăturilor poliesterice filamentare cu selectarea valorilor optime pentru parametrii luaţi în studiu: concentraţia alcaliilor, temperatura şi durata de tratare.

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THERMODYNAMIC AND KINETICS PARAMETERS FOR THE TINCTORIAL SYSTEM WOOL–ACID DYES

BY

GH. IONESCU, AURELIA GRIGORIU, IRINA IONESCU and ELENA CÎDU

The tinctorial system wool–acid dyes can be optimized using a mathematical description of the thermodynamic and kinetics studies, getting more information about the optimal parameters practically acceptable.

1. Introduction. For more than 50 years [1], [2], colorists and dyers have been concerned in selecting dyes for mixture dyeing with the same technological class. The tinctorial features of the dyes that are due to the kinetics and thermodynamics of the sorption process are the basis of getting the best recipes (meaning the hue, the uniformity, the resistances) [3],...,[6].

The mathematical description and according to this, the optimizing of the tinctorial process, needs thermodynamic and kinetic studies as an initial source of data.

2. Experimental. This work proposes a study for establishing the following kinetic and thermodynamic parameters: the equilibrium concentrations of the dyes in the textile fibre ($C_{f\infty}$) and in the bath ($C_{s\infty}$); the affinity of the dye for the fibre ($-\Delta\mu^{\circ}$) and the constant of the dye repartition between bath and fibre (K_{∞}); time of the half dyeing ($t_{1/2}$).

The main purpose was decreasing the time of getting these parameters. There was developed an adequate mathematical processing of the experimental data and a satisfactory precision was accomplished.

The preliminary experimental data dropped to the conclusion that the study should consider the following aspects: the experimental establishing of the kinetic curves $C_{f_i}=f(t_i)$ for different dyes and different temperatures; the mathematical interpretation of kinetic curves in order to linearize them in their first part; the calcules of the measures above, using the parameters of the line obtained on the basis of the experimental data.

These experiments were made for 9 acid dyes using wool as a fiber (Table 1).

3. Results The kinetic curves $C_{f_i}=f(t_i)$ were drawn, where C_{f_i} is the concentration of the dye in the fibre, in the dyeing moment t_i. These curves are similar to a L a n g m u i r absorbtion isotherms (Fig. 1). These curves were straighten and the

Table 1

Thermodynamic and Kinetic Parameters at 60° C

No.	Dye chemical structure	C_f, [%]	$-\Delta\mu^\circ$, [J/mol]	$t_{1/2}$, [min]
1	CI Acid Red 16	3.373	33726	8.4
2	CI Acid Red 33	1.62	28098	23.8
3	CI Acid Red 44	3.165	32081	38.6
4	CI Acid Red 85	3.0	31610	9.0
5	CI Acid Red 263	1.176	27219	11.76
6	CI Acid Orange 67	3.478	33082	15.65
7	CI Acid Green 25	0.887	25800	15.1
8	CI Acid Blue 25	4.335	31218	10.14
9	CI Acid Blue 280	2.667	30729	4.67

equation of a straight line was got:

$$\frac{t_i}{10^3 C_{f_i}} = \frac{1}{K_2} + \frac{K_1}{K_2} \cdot t_i$$

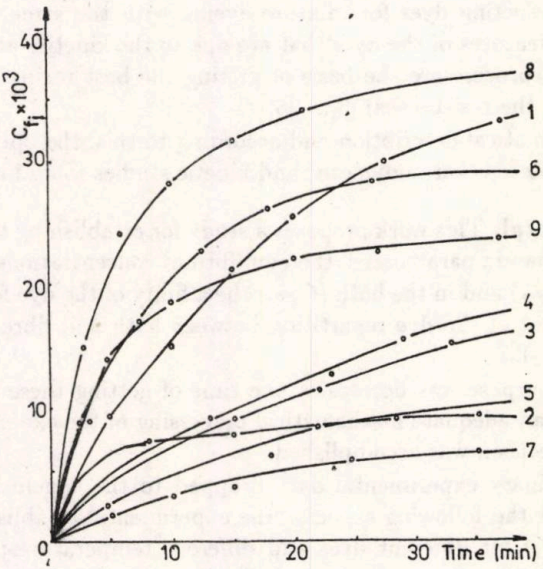

Fig. 1

The constant values K_1 and K_2 are linked to the thermodynamic measures ($C_{f\infty}$) – the concentration of the dye in the fibre at equilibrium or to the kinetic measures ($t_{1/2}$ – time to divide into halves of the equilibrium concentration) according to the following equation:

$$\frac{K_1}{K_2} = 10^3 C_{f\infty} \quad \text{and} \quad K_2 = \frac{10^3 C_{f\infty}}{t_{1/2}}$$

The linear equation of the kinetic curves will be:

$$\frac{t_i}{10^3 C_{f_i}} = \frac{t_{1/2}}{10^3 C_{f\infty}} + \frac{t_i}{10^3 C_{f\infty}}$$

Using the parameters of the straight line can calculate: the concentration of the dye in the fibre at equilibrium (the slope the straight line); the time of half dyeing (the ordinate in the origin).

Then, one can calculate the concentration of the solution at equilibrium $C_{s\infty}$ and the constant of the dye distribution to the solution and bath:

$$K_\infty = \frac{\%C_{f\infty}}{C_{s\infty}} \cdot \frac{1}{V_{ef}},$$

and finally, the standard affinity:

$$-\Delta\mu^\circ = RT \ln K_\infty.$$

The different chemical structure of the 9 studied dyes has considerably influenced in thermodynamic and kinetic parameters of the process.

The slightly different values of the $t_{1/2}$ make evident the different speeds of sorption, depending on structure and frequency of the functional groups with affinity to the fibre.

4. Conclusions.

1° A laboratory method and a mathematical processing for interpreting the initial kinetics curves are proposed in order to determine the following measures: the dye concentration in fibre at equilibrium ($C_{f\infty}$), the constant of equilibrium (K_∞), the standard affinity ($-\Delta\mu^\circ$), and the time of half dyeing.

These measures are absolutely necessary for a thermodynamic and kinetic characterization of a dyeing process, without getting to a equilibrium state which requires a longer time.

2° A quick determination of the affinity ($-\Delta\mu^\circ$) has been made which allows the comparision in optimal time measure for different colours reacting to the fibre. The profound studies were then centred on apreciating the capacity of combination of colours using spectroscopic methods or colours measurements.

3° A quick determination of the time of half dyeing $t_{1/2}$ has been made, used in the evaluation of a dyeing process duration, at a certain temperature. The corelation between $t_{1/2}$ and temperature allows the choice of the dyeing temperature so that the process duration should be practically acceptable.

The quick determination of the equilibrium concentration from the fiber ($C_{f\infty}$) gives information on the initial concentration needed in practice of dyeing, which must be bigger so that the length of the process should be acceptable.

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PARAMETRII TERMODINAMICI ŞI CINETICI PENTRU SISTEMUL TINCTORIAL LÂNĂ–COLORANŢI ACIZI

(Rezumat)

Sistemul tinctorial lână–coloranţi acizi poate fi optimizat folosind o metodă matematică de prelucrare a datelor cinetice şi termodinamice. Se obţin astfel mai multe informaţii despre parametrii optimi acceptaţi industrial.

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TEXTILE. PIELĂRIE

CONTRIBUTION À LA CONNAISSANCE DU PHÉNOMÈNE D'EXUDATION DES OLIGOMÈRES DU PET (POLYÉTHYLÈNE TÉRÉPHTALATE) DANS LE PROCESSUS DE TEINTURE DES FIBRES DE POLYESTER AVEC DES COLORANTS DE DISPERSION À HAUTES TEMPÉRATURES

PAR

MARIN DINU, VALERIA NISTOR et GH.-FLORIN DINU

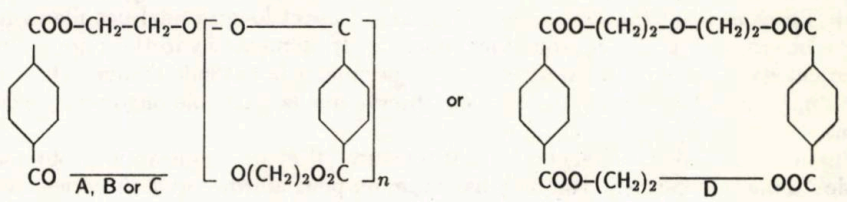
Dans le processus de teinture des fibres de polyester avec des colorants de dispersion à hautes températures, les oligomères du polyéthylène téréphtalate exudent sur la surface des filaments.

Pour élucider ce phénomène, on a traité la fibre de polyester (sous forme de ruban) dans les conditions de teinture avec des colorants de dispersion à hautes températures (dans des bains blancs).

La surface des filaments traités de cette manière a été égalisée sur un microscope électronique à balayage, en mettant en évidence le mécanisme de l'exudation des oligomères sur la surface des filaments.

L'identification et le dosage des oligomères ont été exécutés par l'analyse de spectrophotométrie d'absorbtion en ultraviolet.

1. Introduction. Les fibres industrielles de polyester contiennent normalement 1,5...3,5% oligomères cycliques formés au cours du processus de transestérification; leurs formules structurales peuvent être représentées schématiquement comme il suit [1]:



où: n=2,3 ou 4.

Le composant principale est l'oligomère. A, dont le cycle contient trois unités monomères. De tels composants cycliques se trouvent en équilibre avec les formes linéaires, en permettant leur exudation à la surface, à mesure que la température hausse.

Pour l'explication du phénomène de formation des oligomères cycliques on a pris eu considération les trois possibilités suivantes [1]:

- la cyclisation des oligomères linéaires à chaîne courte;
- l'attaque d'un groupe marginal sur une liaison estérique;
- la réaction d'échamge entre les groupes estériques de la même chaîne ou de chaînes différentes.

La dernière réaction représente le mécanisme le plus plausible [2].

A l'aide du spectre U.V. on peut caractériser les oligomères linéaires et cycliques au compte de l'absorbtion du noyau aromatique aux carboxyles conjugnés [3].

On a constaté que les filaments filés contiennent le plus haut pourcentage d'oligomères. Ce contenu varie en fonction des conditions d'étirage, texturation, fixation et teinture. Dans ce sens, sur la cuticule des filaments filés et non-étirés on a remarqué des exudations liquides et sur ceux étirés, des stries superficielles [4].

Les oligomères diminuent après l'étirage et la texturation, car ils s'éliminent plus fortement dans le processus de teinture, à cause du fait qu'ils passent des filaments dans le bain de teinture en s'éliminant en même temps que celui-ci [4], [5].

La migration des oligomères de l'intérieur vers la surface des filaments est facilitée par la température et l'humidité, ce fait provoquant dans le processus de teinture leur transfert dans le bain de teinture sous forme de dispersion, d'où ils peuvent se fixer et solidifier sur la surface des filaments ou d'autres produits finis, en leur conférant une rugosité superficielle, qui crée des difficultés dans les filatures. Par leur détachement, surtout pendant les usinages textiles, les oligomères déterminent une atmosphère poussiéreuse nuisible dans les enceintes.

Pour tous les traitements hydrothermiques (lavage, teinture, etc.) on recommande des températures au dessus de 80°C, pour éviter la solidification des oligomères sur le tissu [3].

2. Partie Expérimentale. Pour éclaircir le mécanisme d'exudation des oligomères sur la surface des filaments de polyester, on a traité le ruban de polyester dans les conditions de teinture avec des colorants de dispersion, mais sans colorant, à la température de 130°C pendant 90 minutes (durée de teinture, pour les couleurs foncées). Le traitement a été exécuté en bains blancs, car la présence du colorant dans le bain et sur la fibre aurait influencé négativement les résultats des analyses.

Après le traitement, la fibre a été séchée et le bain soumis à une évaporation sous vide et à un séchage du résidu obtenu, jusqu'à la masse constante.

La surface d'un grand nombre de filaments traités de cette manière a été analysée à un microscope électronique à balayage de type REM 100U.

Cette étude a pu mettre en évidence les étapes d'exudation des oligomères (Figs. 1,...,3). En examinant l'image microscopique de l'aspect longitudinal des filaments on a pu observer (Fig. 1) que, sous l'influence des traitements hydrothermiques, un gonflement de la cuticule apparaît et sur son périmètre la cuticule craque. Dans la même image (Fig. 1 en bas de la page) on observe que la particule oligomérique est rompue.

Tenant compte des références de la littérature [4] et des informations obtenus à l'aide du microscope électronique à balayage, on peut affirmer qu'à l'intérieur des filaments, sous la cuticule, il y a des zones avec des agglomérations d'oligomères. Sous l'action de la température et de l'humidité (dans certains cas) ce contenu fluidisé à très grande viscosité exerce une pression sur la cuticule qui craque et fait éruption à la surface des filaments (le phénomène peut être comparé à l'éruption du pus dans un abcès).

L'oligomère, dans cet état, peut rester fixé dans un cratère (Fig.1 dans la partie inférieure de l'image) ou peut se détacher du cratére (Fig. 2) et passer dans le bain d'où il peut se fixer de nouveau sur la surface des filaments (Fig. 3) et après, il cristallise.

Les particules oligomères visqueuses, à des températures sous 80°C, se solidifient,

cristallisant d'une manière différente sur la surface du filament, à l'emplacement où elles ont fait éruption (Fig. 1) ou sur d'autres portions de la surface (Fig. 3).

Fig. 1.– L'éruption des oligomères cycliques du téréphtalate de polyethylène pendant le processus de teinture à hautes températures *a* – la surface du filament avant l'éruption; *b* – la surface du filament après l'éruption.

Fig. 2.– Le cratère résulté à la suite de l'éruption d'une particule oligomérique.

Fig. 3.– Particule oligomère fixée sur la surface d'un filament de polyester.

Fig. 4.– Cristaux de sels de calcium.

Dans la Fig. 3 on observe une partie de la cuticule du filament d'où a fait éruption l'oligomère, fixée sur celui-ci.

Les déterminations quantitatives d'oligomères de la surface des filaments de polyester ont été exécutées par extraction en dichlorméthane en utilisant un spectrophotomêtre UV-VIS-longueur d'onde 241 nm.

Le résidu qui reste après l'évaporation du bain blanc a été analysé sur un spectrophotomètre d'absorbtion en infrarouge et visualisé à un microscope électronique à balayage. En examinant les spectres IR et l'image microscopique (Fig. 4) on est arrivé à la conclusion que le résidu résulté après l'évaporation du bain est constitué surtout de sels de calcium cristallisés provenus de l'eau qui a été insuffisamment dédurisée.

Tout ce qu'on a présenté jusqu'ici met en évidence que les particules solides existant dans le bain à la fin de la teinture (supposées d'être des oligomères) sont en réalité des sels de calcium cristallisés par refroidissement en formations cristallines caractéristiques (Fig. 4).

3. Conclusions. L'exudation des particules oligomères à la surface des filaments de polyester a lieu à la suite de l'éruption du contenu oligomérique visqueux par la cuticule des filaments à cause des hautes températures.

Ce contenu ou bien, reste fixé dans le cratère et cristallise, ou bien se détache du cratère et se fixe par l'intermédiaire du bain sur d'autres parties des filaments, après quoi, il cristallise, quand la température du milieu où il se trouve, baisse sous 80°C (fig.3).

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CONTRIBUŢIE LA CUNOAŞTEREA FENOMENULUI DE EXUDARE A OLIGOMERILOR POLIETILENTEREFTALATULUI, ÎN PROCESUL DE VOPSIRE A FIBRELOR POLIESTERICE CU COLORANŢI DE DISPERSIE LA TEMPERATURI ÎNALTE

(Rezumat)

În procesul de vopsire a fibrelor poliesterice, cu coloranţi de dispersie la temperaturi inalte, oligomerii polietilentereftalatului exudează pe suprafaţa filamentelor.

Pentru elucidarea acestui fenomen s-a tratat fibra poliesterică (sub formă de pală) în condiţiile vopsirii cu coloranţi de dispersie la temperaturi înalte (în flote oarbe).

Suprafaţa filamentelor astfel tratate a fost analizată pe un microscop electronic cu baleiaj, punându-se în evidenţă mecanismul exudării oligomerilor pe suprafaţa filamentelor.

Identificarea şi dozarea oligomerilor s-a făcut prin analize de spectrofotometrie de absorbţie în ultraviolet.

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CONSIDERATIONS ON DEPOLLUTION OF WASTE WATERS IN TANNERIES

BY
IRIDENTA-DOINA COSTAŞ, N. BADEA, FLORIN VITAN, CECILIA-LUCREŢIA BADEA, AL. MĂLEANU and VASILICA MAIER

The protection of water quality is a basic constituent of the environmental protection; it responds to some acute necessities of life, industry and agriculture, of civilization generally speaking.

This paper tackles some aspects concerning the industrial ecology and has in view the decreasing of toxic matters in discharged waters. Concrete proposals for treating some floats with high pollutant charge and pretreating of final effluents are made.

The environmental protection represents the totality of activities provided by mankind in order to preserve the ecological ballance, to maintain and improve the quality of natural factors, to develop the material and spiritual values, to offer better life and labour conditions for present and future generations. Intervening upon biosphere, man has essentialy modified the enviromment acconding to his needs. The great stability characterizing the biosphere generated the false belief that it has the possibility to annihilate all poisonous influences it is submitted to.

Environmental protection is therefore of extreme importance for mankind and has become a stringent problem of the global policy, which requires scientific solutions, implicating governments all over the world [1], [2].

Water pollution is defined as the alteration of physical, chemical and biological quality of water, as a direct or indirect result of human activities, making it improper for normal use. It is forbidden to discharge waste waters containing polluting agents over the prescribed figures, without a preliminary treatment made in order to reduce these concentrations [3].

The discharge of waste waters into public drain network is stipulated in "Regulations concerning conditions of waste water discharge into the drain network of populated centers" – code C-90/'83 [4], so that the content and quality of effluent should not reduce the transport capacity and affect the installations, harm the personnel working in this branch and should not pollute water, air or soil.

The Law 414/'79 establishes the limit inlet values for the main polluant substances from waste waters before discharging them into water flows, lakes, Black Sea and underground water network [5].

Government Decision No. 1001/90 establishes the costs of water supply service and also penalties for overflowing daily average values of water quality indicators as

given by the legislation. So, for 1 kg Na_2S discharged in the effluent, the penalty is 100 lei, and since this year ('96), it will double, until normal parameters of water quality will be attained [6].

The study of wast water depolluation in leather industry is vast, complex and the direction is given by the shortest and riskless way.

From the beginning, it must be made a separation between tanneries depending on the nature of discharge receptor, as follows:

1. tanneries discharging the effluents into drain network of urban centers;
2. tanneries discharging the waste waters into a natural water flow (i.e., river).

In the first case, Legislation C-90/'83 is applied, and the quality indicators of water may be achieved by some preventive treatments to eliminate pollution, for example, recovery of useful substances by means of physico-chemical procedures. In the second case opperates the Law No. 414/'79 and the water quality indicators may be attained only by using a secondary purifying treatment, a biological one, that follows the primary physico-chemical process.

Therefore, the necessity of a secondary biological purifying treatment occures only in situation of discharging wasted waters into a natural receptor. In the first case, the secondary biological purifying treatment is useless because in urban drain network are discharged other effluents treated only by means of physico-chemical procedures and so became necessary water purifying plants which opperate in the two stages shown above.

Complex aspects connected to waste water purification in leather industry are determined by: various chemical composition, the degree of pollution, water consumption, use of different technologies and impose a preliminary study, essential for each tannery separately because of the practical impossibility to design a standard water purifying plant. So, the display of pollution parameters for the different technological stages is noted in Table 1.

From the data above, it results that the highest pollution charge is provided by the two partial effluents, from beamhouse and from tanning operations, containing Na_2S, proteins and chromium salts as main pollutants. In any water purifying treatment it must be taken in account the possibility to recover some of these substances, which leads to exploitation costs discount. In the present situation, when auxiliaries become more and more expensive, the importance of recycling grows day by day.

In order to make a correct approach to the problem of water pollution in leather industry, in the limits of Legislation NC-90/'83, the following steps must be discussed:

1. individual treatment of liming effluent;
2. individual treatment of tanning effluent;
3. final treatment of the global effluent by means of physico-chemical methodes, i.e. by the primary treatments.

In order to discharge waste waters in a natural receptor it is necessary to stipulate a biological stage for purification by one of the following methods: aerating tanks, air oxidation pools or active tannery sludges [7].

Table 1
The values of the pollution parameters for the principal technological stages

Operation	COD %	BOD %	Na_2S %	N_2 %	Cr_2O_3 %
Soaking Rinsing	13–20	18–19	0	9–12	–
Liming	49–65	48–67	79–88	53–84	–
Rinsing Fleshing Splitting	3–7	3–7	11–21	–	–
Rinsing Deliming	5–10	5–7	–	15–18	–
Pickling Tanning	5–6	7–8	–	–	89–96
Neutralization Dyeing Fatliquoring Retanning	4–6	2–4	–	3	5–8

To properly recirculate the effluent after secondary treatments, different methods are used. These are the tertiary treatments, such as chlorination, desalting, filtration [8].

In other countries, the discharged waste waters are strictly separated. For example, in Switzerland the waste waters are separated, accordingly to their pH, into:

- soaking floats and drain floats;
- liming floats and post liming drain floats;
- tanning floats;
- deliming and fatliquoring floars [9].

In France, the ERPAC company, which produces machinery and devices for water purifying plants, recommends, in order to avoid malfunction, that effluents containing Na_2S should be treated separatly using one of the following methods: catalytic oxydation by means of floating surface aerator, using surpressed air or oxidation with hydrogen peroxide [10].

Speaking about the chromium salts, they do not affect the purifying plant function, but increase costs and are subject to penalties when the sludge is used in agriculture. Some possibilities to reduce or avoid these inconvenients are the following:

- optimization of chromium salt offer;
- improvement of basifying process;
- use of ecological products;
- regeneration of chromium sulphate from the effluent;
- recycling of tanning bathes.

In Turkey, at Tuzla tanneries [11], a puryfying plant operates with a capacity of 9000 m^3 waste water daily and, to process the effluents, they are separated into three groups:

- effluents containing sulphides;
- effluents with chrome content;
- other effluents.

To process the liming effluents, some methods are used, as follows:

1. treatment with iron salts, generally used in all purifying plants in Romania; its inconvenients are a large amount of sludge and the fact that sodium sulphide is not destroyed but only precipitated;
2. treatment with combustion gases provides a desulphuration capacity of 65...70 percent and raises the issue of corrosion;
3. catalytic oxydation with air oxygen, most used, with lowest costs, the most important factor being the choice of catalyzer and a satisfactory aeration;
4. chemical oxydation with peroxides, rarely used because of high costs and limited area of use;
5. liming waste water recycling, which has a certain degree of technological insecurity, the last float requiring another preventive treatment for desulphuration;
6. recovery of Na_2S by acidifying liming floats, highly toxic because of H_2S coming off;
7. use of artificial membranes in ultrafiltration or electrolytic process in order to separate the proteic phase unchanged and to recycle solved salts;
8. change of liming technology to diminish concentration in sulphide and the amount of waste water, or to eliminate natrium sulphide and replacing it with oxidizing agents (chlorine dioxide, peracetic acid), with enzymes or with ethylsulphydrate; presently, such liming technologies are not used due to high costs, tanners prefering to use the ordinary Na_2S;
9. recovery of dissolved or hydrolised proteins after the desulphuration provided by one of the previous methods.

The most up-to-date desulphuration method is catalytic oxydation. The parameters of this reaction and the parameters of the protein recovery were established by experiments. The major advantages of this method are:

- efficiency proportionally with Na_2S concentration;
- very small amount of catalyzer used;
- minimal volume of treatment float;
- no H_2S come off;
- catalyzer ($MnSO_4$) produced in Romania in sufficient amount.

Use of anionic macromolecular polyelectrolytes on base of dicarboxylic acids containing Mn^{2+} in catalytic oxydation ensures the total and irrevesrible removal of Na_2S. Acid treatment for protein recovery must be done only after the operation shown above. So the two aims are achieved, the removal of a very dangerous pollutant from the effluent and a significant amount of materials containing organic nitrogen are recycled. Recovered proteins can be used as:

- filling auxiliary for upper leather;
- fertilizer in agriculture;
- component in a food receipt for chicken farms.

It must be pointed out the difference between fertilizers obtained by ammonium synthesis and those prepared as described above, but the most important aspect concerning the use of this protein is pollution reduction in comparison with indusrty of inorganic ammonium fertilizers. Pollution caused by the inorganic fertilizers is in our days one of the most important and most discussed problem of health [12]. Use of inorganic ammonium fertilizers increases nitrits concentration in soil and water sources, the effect consisting in a larger number of diseases affecting especially children.

In 1978, for tanning effluent treatment were suggested [13] some methods which can be in the following groups:

1. optimization of technologic processes and use of new auxiliaries in tannery;
2. partial replacement of chromium with another tanning agent;
3. direct recycling of waste water;
4. precipitation of chromium salts as $Cr(OH)_3$.

In 1987 the classification was the same, but a new method was added:

5. use of "ecological products" to reduce chrome offer and to improve tanning bath exhausting.

The future of chrome tanning is connected not only with the improvement of tanning technology for high quality leather, but also with the environmental protection standards. Chrome tanned leathergoods represent almost 90 percent of the market, due to a good quality and economic efficiency in comparison with other alternatives. The dominating position of chrome tanning is based on reliable scientific and technologic arguments, on quality and economic efficiency, representing a strong upholder of tannery as an activity using natural resources. It was concluded, after studying other tanning methods, that such leather has inferior quality with respect to clasic chrome tanned leather. The aluminium tanning is reversible and leather is not water resistant. It is also known that, under certain conditions, aluminium is more harmful than chromium. It's presence in soil inhibits plant growth. Zirconium and titanium salts are better technical alternatives to chromium tanning and, according to available literature, seem to be ecologically harmless, which is not yet proved [14].

Use of vegetable tanning provides an effluent with very high polluting potential, requiring a very large amount of oxygen for depollution. Use of organic products such as: hexamethylendiisocyanate, formaldehyde, glutaraldehyde, a.s.o., with high risks at exposure is an even worse alternative.

Though chrome tanning has proved to be so effective, we must not forget its disadvantages. In conventional tanning technologies at least 1/3 of chromium salt is found in the effluent and the aim is to reduce Cr_2O_3 percentage in waste water.

In countries where environmental protection legislation is more devloped, discharging solid wastes and sludges is forbidden due to organic material and chromium salts content. The most radical method to solve problems concerning chromium toxicity is precipitation of chromium basic salts from tanning waste water. Obviously, chromium recovery is a way to reduce wastes and to increase economic efficiency of the tanning technology, an indirect recycling that ensures a further highly secured

tanning operation, in comparison with the direct recycling. Our research team provided industrial experiments and established technological recovery parameters by chromium salts precipitation. The main methods used are:

1. precipitation with MgO;
2. precipitation with usual alkali, followed by a treatment with polyelectrolytes.

The chromium hydroxide can be processed as follows:

1. direct reversion to basic salts by adding a calculated amount of sulphuric acid to obtain a certain basicity;
2. transformation into chromium sulphate by adding a calculated amount of sulphuric acid in excess and using this mixture in a new reduction of natrium dichromate;
3. use of chromium hydroxide in basifying operation.

The physico-chemical analyses of leather samples have values according to our standard requirements and the aspect of leather is similar to current production.

The problem of pollution caused by chrome tanning may be solved improving tanning technology by using so called "ecological" auxiliaires which lower chromium salts offer and diminish chromium content of waste water.

Discovery of dicarboxylic macromolecular polyelectrolytes suggested the ide. that they can act similar to dicarboxylic acids, increasing the affinity of chromium complexes for collagen, so their fixation is improved. The experiments provided by our research team with polyelectrolytes of a certain molecular weight allowed us to lower chromium salts offer for hides up to 1.5...1.7 percent and the chromium content of tanning waste water was about 0.2...0.5 g/l Cr_2O_3. Remarcable is the fact that polyelectrolytes ensure the same fixing action when retaning leather with chromium salts, no supplementary amount required.

In special situations and under strict labour protection conditions, when large amounts of dyestuff are used (from 5 to 10 percent of the shaved weight of leather), bleaching treatments are recommended in order to:

- regain water transparency;
- remove dyestuff.

Bleaching of waste waters can be provided with adsorbant active coal (decolorizing carbon).

The separation of heavy charged effluents from individual technological o. erations imposes modifications of the existing drain networks, but costs are lower than gains in economic and ecologic levels. So, by preventive treatment of some floats, the problem of pollution has a new dimension, the global mixture of waste waters entering the predepollution plants having a considerable lower polluting charge. Predepollution has the next stages:

1. pretreatments (physico-mechanical operations);
2. homogenization of effluents;
3. primary decanting;
4. chemical treatment of effluents by means of coagulation and flocculation;
5. secondary decanting;

6. treatment of residual sludge.

Flocculation leads to an important diminution of sludge volume. The main problem is to choose the right type of flocculant and it must be taken in account the ratio cost/efficiency and other criteria such as: accessibility, reproductibility, toxicity, tolerance, manipulation, storage and posibility of industrial production. However, the most important is the criterion of toxicity. For example, polyacrylamide is not allowed nor for the treatment of drinkable water neither for other effluents which shall be discharged after purification into water flows which may be used as drinkable water preparation. This is due to the fact that the water soluble monomer acrylamide is toxic, may generate cancer [15] and its removal from water is very difficult.

Flocculants based on dicarboxylic acids do not have toxicity at the used concentration. The tests made at the Institute of Hygiene Jassy placed dicarboxylic acids in 4-th class of toxicity, which means practically non toxic. Flocculants based on dicarboxylic acids present other qualities such as: stirring resistance and easy dissolution in water. Raw material for processing these acids exists in satisfactory amounts in Romanian chemical industry. To diminish sludge volume:

- sludge thickeners;
- drying beds;
- filtering with filter press;
- vacuum filtering;
- centrifugation are used.

Social pressure occurring in the field of waste waters must lead to skilled and exacting labour formation in environmental protection area. The personnel in purifying plants must posess a through acquaintance with either theoretical or practical aspects concerning waste waters discharge and with those connected with maintainance and control of the new depolluting systems.

Environmental protection approach is no longer purely economic. The solution consists in new designed technologies able first to diminish wastes and then economical efficiency should be increased by recovery of organic and inorganic matters.

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ASPECTE PRIVIND DEPOLUAREA APELOR DEVERSATE DE INDUSTRIA DE PIELĂRIE

(Rezumat)

Protecţia calităţii apelor constituie parte integrantă a protecţiei mediului înconjurător, răspunzând unor necesităţi stringente ale vieţii, ale industriei şi agriculturii, ale civilizaţiei în general.

Lucrarea abordează un subiect de ecologie industrială şi are ca obiectiv diminuarea pătrunderii substanţelor toxice în apele uzate, cu propuneri concrete de tratare şi recuperare a unor flote cu încărcătură poluantă ridicată, precum şi preepurarea efluentului final.

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Secţia VIII
TEXTILE. PIELĂRIE

THE THERMODYNAMICS OF BRILLIANT RED HE-3B REACTIVE DYE RECOVERY FROM WASTE WATERS OF TEXTILE INDUSTRY

BY

DANIELA ŞUTEU and LAVINIA TOFAN

The thermodynamic of sorption of the reactive dye Brilliant Red HE-3B on anion exchange celluloses and ion exchange resins was studied using Langmuir isotherms equations at three temperatures.

By using the calculated values of the thermodynamic parameters, there is made an attempt to find out the optimum sorbent for reactive dye Brilliant Red HE-3B recovery from waste waters of dyeing processes of fibers.

1. Introduction. One of the most important problems related to the environment is decontamination of waste waters impurified with differents organic substances included textiles dyes [1].

Waste waters are impurified with various amounts of dyes as a result of dyeing process of fibers.

The literature of the field provides scarce informations concerning dye concentration in natural waters and long term toxicity of dyes [2]. Due to high number of used dyes and their structural diversity, a general method for elimination of residual dyes is practically impossible.

For the decontamination of waste waters impurified with dyes, some methods including precipitation of the dyes with metallic salts [2], ion exchange [3] and sorption on activated carbon [4],...,[6], chitosan fibers [7], several low-cost materials (teakwood bark, bentonite clay, etc.) [8], nonconventionally cellulosic sorbents [9],...,[11], synthetic polymers (cellulose-epichlorohydrine) [12], [13] and combined methods (ion exchange–physical sorption or Donnan distribution) on different supports [14],...,[16] have been proposed.

The results of a comparative thermodynamic study concerning the removal of the Brilliant Red HE-3B reactive dye from waste waters by use of ion exchange resins and ion exchange cellulose are presented in this work.

2. Experimental. The sorption experiments of monochlortriazinic bifunctional Brilliant Red HE-3B reactive dye (Fig.1) have been accomplished with using a stock aqueous solution (1.367×10^{-2} M) from which working solutions with $(6.835...1.367)\times$ $\times10^{-5}$ M ($(0.1...2)\times10^{-2}$ mg/L) concentrations were prepared.

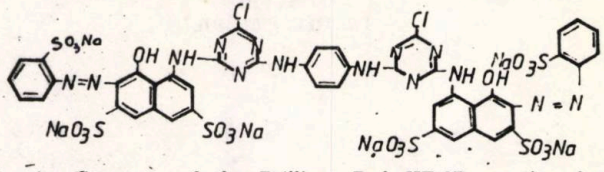

Fig. 1.- Structure of the Brilliant Red HE-3B reactive dye.

Dye concentration was measured on using Cecil 1020 model UV-VIZ spectrophotometer at a wavelength, $\lambda_{max} = 530$ nm ($\varepsilon = 38769$ L×mol^{-1}×cm^{-1}).

In work we used the following sorbents: five anionites cellulose, with the properties shown in Table 1, have been used as ion exchangers; three ion exchange resins which are styrene-divinylbenzene copolymers with quaternary amine groups (type I), gel structure and ion exchange capacity of 1.1...1.3 mval/ml: Vionit AT-1 and Purolite A-400, strong basic anion exchangers and Amberlite IRA-401 S, a strong basic adsorbent.

Table 1

Specific Features of the Anionites Celluloses Exchange

Cellulose derivates (Serva)	Functional group	Exchange capacity (mechiv/L)	pH of max. exchange capacity
AE	$-OC_2H_4NH_2$	0.8±0.1	8.0
DEAE	$-OC_2H_4N^+H(C_2H_5)Cl^-$	0.7±0.1	9.5
TEAE	$-OC_2H_4N^+(C_2H_5)_3Cl^-$	0.5±0.1	-
GE	$-OC_2H_4NH-C(NH_2)=NH$	0.4±0.1	7.5
ECTEOLA	$-O(CH_2CH(OH))_nOC_2H_4N(C_2H_4OH)_2$	0.3±0.05	-

The study of Brilliant Red HE-3B dye retention on different types of ion celluloses exchangers has been carried out in static conditions, using samples of about 0.2 g cellulose anionites and 100 mL solution containing determined amounts of dye.

After a certain contact time, the phases were separated by filtration and the unretained amount of dye was determined in solution by spectrophotometric method.

3. Results and Discussion. In view of calculating the thermodynamic values, the dependence of the equilibrium distribution of the dye between the sorbent phase and solution on differents temperatures has been studied and represented as Langmuir sorbtion isotherms (Figs. 2 and 3).

Taking into account the Langmuir equation:

$$q = \frac{KC_e q_0}{1 + KC_e}, \tag{1}$$

where: K is the retention constant, [mL/mg]; C_e – dye solution concentration at equilibrium, [mg/mL]; q – retained dye amount, [mg/g]; q_0 – maximum sorption capacity, [mg/g].

The plot $1/q$ vs. $1/C_e$, at different temperatures, allows calculating the Langmuir constant, K_L, the maximum capacity of sorbtion and the quantitative values of the retention process (Table 2).

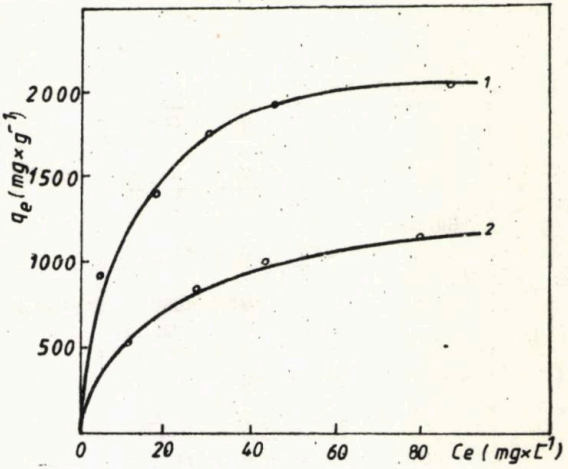

Fig. 2.– Langmuir plots for the retention of Brilliant Red HE-3B on cellulose: *1* – DEAE, *2* – ECTEOLA, at 22°C temperature.

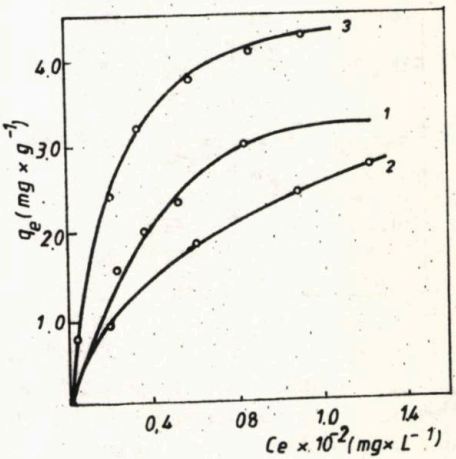

Fig. 3.– Langmuir plots for the retention of Brilliant Red HE-3B on anion exchange resins: *1* – VIONIT AT-1; *2* – PUROLITE A-400; *3* – AMBERLITE IRA-401S, at 22°C temperature.

Table 2 shows that both the Langmuir constant (K_L) and the maximum sorption capacity (q_0) increase with temperature. The calculated values of the maximum sorption capacity (q_0) are higher than those for the theoretical capacity of each sorbent type (Table 2). This fact can be explained by the surfaces physical adsorption and the possibility of covalent bonding of the bifunctional monochlortriasinic Brilliant Red HE-3B dye on the substrates, which occur simultaneously with the ion exchange process.

Using Langmuir constants, the thermodynamic parameters characterizing the process have been calculated (Table 2).

The variation of Gibbs free energy (ΔG) was determined using relation: $\Delta G = -RT \ln K_L$, while the enthalpy variation (ΔH) was determined from the slope of the straight line for $\ln K$ vs. T^{-1}. The enthropy variation (ΔS) for the studied systems

Table 2

The Values of Langmuir Constants and Thermodynamic Parameters for Brilliant Red HE-3B Reactive Dye Sorption on Different Sorbents

		Langmuir constant		Thermodynamic parameters		
	T	K_L	q_0	$\Delta H \times 10^3$	ΔG	ΔS
Sorbents	K	L/g	mg/g	J/mol	J/mol	J/mol×grd
AE	275	0.3	1111.11		+1579.7	
cellulose	298	3.0	1666.67	+46.26	−2729.11	+227.01
	328	13.49	6666.67		−7100.0	
DEAE	275	0.361	1052.0		+2335.3	
cellulose	298	10.2	1666.67	+46.25	−5755.8	+166.84
	328	23.1	2222.22		−8328.9	
TEAE	275	12.0	2222.22		−5723.8	
cellulose	298	32.9	3333.0	+55.52	−8683.52	+212.47
	328	37.8	5555.55		−9830.8	
GE	275	10.0	344.83		−5265.9	
cellulose	298	16.0	1111.11	+21.91	−6946.8	+96.49
	328	18.0	4000.0		−7919.2	
ECTEOLA	275	1.2	1176.47		−416.7	
cellulose	298	14.6	3333.33	+92.51	−7318.5	+326.69
	328	28.0	6666.67		−8311.4	
VIONIT	275	0.148	3.08		+4375.36	
AT-1	298	0.325	4.0	+23.79	+3538.9	+69.6
	328	0.44	8.0		+2114.1	
AMBER-	275	0.69	4.54		+847.59	
LITE	298	1.11	4.76	+27.74	−258.02	+95.36
IRA-401S	328	1.818	5.71		−1559.0	
PURO-	275	0.1064	2.17		+5131.07	
LITE	298	0.1923	3.84	+36.2	+4054.6	+109.61
A-400	328	0.3571	6.25		+2685.3	

was calculated with $T\Delta S = \Delta H - \Delta G$ relation.

The positive values of enthalpy (ΔH) demonstrate the retention processes are endothermic and temperatures increasing influences positively the fixed amount of dye, due to the diffusion rate increase.

The Gibbs free energy values (ΔG) are positive if the thermodynamic constant of equilibrium K_L is smaller then 1 ($K_L < 1$) and negative in the others instanees, which demonstrates that the processes are spontaneous in the considerated sens, from left to right.

The higher values of the systems enthropy (ΔS) show the strongest interaction between the dyes sorbed and support.

The maximum capacity of retention (q_0) values which are closely or greater then the specific theoretical capacity for every support prove that the respective support (for example: AE or ECTEOLA cellulose at 328 K) exhibits a good capacity of retention, both by a mechanism of ion exchange and covalent bonding.

4. Conclusions. For the batch recovery of monochlortriazinic bifunctional reactive dye Red Brilliant HE-3B on anion exchange cellulose (AE, DEAE, TEAE, GE,

ECTEOLA) and synthetic anions exchanges (VIONIT AT-1, AMBERLITE IRA 401 S. PUROLITE A-400), the thermodynamic constants of the retention process, the maximum capacities of retention as well as the characteristic thermodynamic values have been estimated from the Langmuir isotherms of sorption, calculated at three temperature.

The data shown in Table 2 point out that the anion exchange cellulose of five types have a better capacity of retention for the tested dye, found out even at high concentrations, in waste waters from dyeing processes, than the synthetic anion exchange resins. This fact can be explained by the existance of some different internal structure for both types of support (a loose structure with a certain distribution of macropores and pores for celluloses and a rigid structure with pores only at surface in the case of resins).

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TERMODINAMICA RECUPERĂRII COLORANTULUI REACTIV ROŞU BRILIANT HE-3B DIN APELE REZIDUALE ALE INDUSTRIEI TEXTILE

(Rezumat)

Termodinamica sorbţiei colorantului reactiv Roşu Briliant HE-3B pe celuloze schimbătoare de ioni şi pe răşini sintetice schimbătoare de anioni a fost studiată utilizând ecuaţia izotermei Langmuir la diferite temperaturi.

Folosind valorile calculate pentru mărimile termodinamice caracteristice procesului de sorbţie, s-a incercat estimarea celui mai bun sorbent pentru recuperarea acestui colorant din apele reziduale ale proceselor de vopsire ale fibrelor.

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Secţia VIII
TEXTILE. PIELĂRIE

ASSEMBLY LINE BALANCING: FUZZY MODELLING AND SOLVING TECHNIQUES

BY

OCTAV BRUDARU and COSTACHE RUSU

We deal with the assembly line balancing problem and consider that the execution times of tasks are real sampled fuzzy numbers. We redefine the main restriction and the goal function and describe the core algorithm derived from a greedy approach. The way to extend the mathematical model and the proposed algorithm to mixed models and parallel work stations assembly line is also discussed. Some open problems are also outlined.

1. Introduction. The practical use of the assembly line balancing [1] appeared for the first time in the industrial practice 75 years ago in the Ford Systems. Since its first mathematical formulation [2] this problem was both intensively and extensively studied in order to find more efficient solving methods and to extend the model for handling new restrictions. The study of this problem remains of a continuous interest [3]. A monograph dedicated to this subject including both the deterministic and stochastic task execution times, unique or mixed models of a product, purely serial or parallel work stations, planed unbalance pre-assignment of tasks, prescribed sided tasks, skill levels, task separation as well as a large fun of exact and heuristic methods can be found in [4]. It is worth mentioning that this problem appears in any type of industry which involves assembly processes.

The assembly line balancing (ALB) problem classically concerns the manufacturing or robotized production systems. In the last years, it appears in VLSI technology and parallel computation [5] and is related to the partitioning of the data dependency graph in order to design networks of processors able to pipeline computations and data. This new application of the ALB problem increases the interest to continue the investigation. Recently, the considering of the fuzzy execution times and the use of genetic algorithms [6] offered a new motivation.

Section 2 presents the deterministic model of ALB. In §**3** we motivate the fuzzy approach, give the basic mathematical tools and present the fuzzy model. Section 4 describes the core algorithm to solve the fuzzy model. Some post-processing techniques for improving the solutions are described in §**5**. In §**6** we discuss the possibility the extend the fuzzy approach to more complicated variants of ALB problem and outline some open problems.

2. Deterministic model. Let us denote by $V = \{1, 2, ..., n\}$ the set of tasks of the assembly process. The order to execute the tasks is restricted be the precedence constraints between tasks. Consider the set of ordered pairs $A \subset V \times V, A \subset V \times V$, where task i must be completed before the beginning of task j. Consider now the digraph $G = (V, A)$, where V is the set of vertices and A – the set of arcs. We suppose that G is acyclic. Let us denote by t_i the positive real number giving the execution time of task i. The time C, elapsed between two successive outputs from the line, is the cycle time. If we have to use only serial work stations then the condition $t_i \leq C$ holds for $i = 1, ..., n$.

Let us denote by $W = \{W_1, ..., W_m\}$ a partition of V which satisfies the following conditions:

$$\bigcup_{i=1}^{m} W_i = V; \tag{1}$$

$$W_i \cap W_j = \phi, \ i \neq j, \ i, j = 1, 2, ..., m; \tag{2}$$

$$\text{if } (x, y) \in A, \ x \in W_r, y \in W_s, \ \text{ then } \ r \leq s; \tag{3}$$

$$T(W_j) = \sum_{i \in W_j} t_i \leq C, \ j = 1, 2, ..., m. \tag{4}$$

Let us denote by S the set of those W satisfying (1)-(4). Each member of S is a *solution* to the ALB problem. The response time $R_T(W) = mC$ of the assembly line (structured following W) is the time elapsed between the introducing and the extracting of the first batch. If B batches are to be assembled along this line then the total processing time is $T_p(W) = R_T(W) + (B-1)C$. Also, the total amount of work is $T_s = BT_{\text{tot}}$ where $T_{\text{tot}} = \sum_{i=1}^{n} t_i$. The efficiency of work stations utilisation is defined as $E_c(W, B) = T_s/(mT_p(W))$, $\overline{E} = \lim_{B \to \infty} E_c(W, B) = T_{\text{tot}}/(mC)$ and always $\overline{E} \leq 1$ due to condition (4). Of course, maximising $\overline{E}$ means minimising the number m of work stations. Alternatively, if we consider the total idle time along the lime, it is given by

$$I_T(W) = \sum_{j=1}^{m} [C - T(W_j)] = mC - T_{\text{tot}}.$$

If we need to minimise I_T, we must minimise m. Therefore, $W^* \in S$ is an *optimal solution* if

$$\text{card}(W^*) \leq \text{card}(W), \ \forall W \in S. \tag{5}$$

This is the classical formulation of the ALB problem and is the simplest variant in the ALB paradigm. It is NP-hard while its associated decision problem is NP-complete.

3. A fuzzy Approach. In this section we present the basic elements of the fuzzy approach modelling of the assembly line balancing problem.

3.1. Why a fuzzy approach? The behaviour of the real world systems has a certain degree of uncertainty and the input data (in present case the execution times) can only estimated. Also, the working of the assembly line in real conditions has uncertain aspects [7]. The first approach in handling this aspects was to consider that the execution times are random variables [8]. In this context, condition (4) is reformulated while the objective is to minimise the mean of the total idle time under the assumption that the processing times are random variables. Although this stochastic model approximates better the reality, the higher complexity of the solving techniques comes as price. So, we should realise a compromise between the accuracy of the model and the complexity of the algorithms to solve it. The best solution is to consider that the execution times are sampled real fuzzy numbers [9]. This is because a fuzzy number can reflect the vague feature of the both predicted and realised processing times while the mathematical tools are simple.

In order to (re)formulate condition (4) and the objective function as well as the basic actions required by they proposed algorithm, we need to add two fuzzy numbers, to compare a fuzzy number with a real number and to compare two fuzzy numbers between them.

3.2. Basic operations with fuzzy numbers. Next, we describe the basic fuzzy operations needed for the model and algorithm description.

3.2.1. Addition of two sampled fuzzy numbers. Suppose we have two sampled real fuzzy numbers $x = ((x_1, p_1), ..., (x_k, p_k))$ and $y = ((y_{1,1}), ..., (y_k, q_k))$, where $x_i, y_i \in \mathbb{R}$ and $p_i(q_i)$ is the value of membership function for $x_i(y_i), p_i, q_i \in [0, 1]$, $i = 1, ..., k$. We assume that $x_i \in (b_{i-1}, b_i]$, where $b_0 = x_0$, $b_i = b_{i-1} + (x_k - x_0)/k$, $i = 2, ..., k-1$. If $z = x + y$ and $z = ((z_1, r_1), ..., (z_k, r_k))$, then we need to compute:

- $a_0 = x_1 + y_1$, $a_k = x_k + y_k$, $h = (a_n - a_0)/k$, $a_i = a_{i-1} + h$, $i = 1, ..., l - 1$. $I_1 = [a_0, a_1]$, $I_i = (a_{i-1}, a_i]$, $i = 2, ..., k$;
- $s_{ij} = x_i + y_j$, $\mu_{ij} = \min(p_i, q_i)$, $i, j = 1, ..., k$;
- for each $l = 1, ..., k$ take $z_l = s_{i^\bullet j^\bullet}$ and $r_l = \mu_{i^\bullet, j^\bullet}$, where $s_{i^\bullet j^\bullet} \in I_l$ and $\mu_{i^\bullet j^\bullet} = \max\{\mu_{ij} / s_{ij} \in I_l\}$.

Note that $u = ((0, 1), ..., (0, 1))$ ensures that $x + u = u + x = x$ for any sampled real fuzzy number.

3.2.2. Comparing a fuzzy number with a real number. We need to compare a fuzzy number with a real number α in order to formulate (4) in a fuzzy manner. To do this we introduce a so-called confidence measure defined below:

$$\text{Conf}(x \leq \alpha) = \frac{\sum\limits_{\frac{x_i \leq \alpha}{k}} p_i}{\sum\limits_{i=1} p_i} \in [0, 1]; \tag{6}$$

his measure is to be compared with a threshold value $c_0 \in (0, 1]$. So, we define

$$x \leq \alpha \Leftrightarrow \mathrm{Conf}(x \leq \alpha) \geq c_0.$$

The value of $\mathrm{Conf}(x \leq \alpha)$ can be interpreted as a measure of confidence [10] in the fact that the X values are less than α [11]. Observe that $x_i > \alpha$, $i = 1, ..., k$ implies that $\mathrm{Conf}(x \leq \alpha) = 0$, while $x_i \leq \alpha$ for $i = 1, ..., k$ leads to $\mathrm{Conf}(x \leq \alpha) = 1$.

3.2.3. Comparison of two fuzzy numbers. The algorithm we propose constructs each work station by assigning one task at a time. This task is extracted from a list of assignable tasks according to some selection criteria. Such a criterion should indicate as favourite those tasks which fill better the existing idle time. These tasks should be compared between them using their fuzzy execution times. So, for ranking the tasks we consider the following defuzzier [9], [12, pp. 244]:

i. the centre of gravity method

$$g(x) = \frac{\sum_{i=1}^{k} x_i p_i}{\sum_{i=1}^{k} p_i}, \tag{7}$$

where x is the fuzzy time of a candidate to this station. So, we define that $x \prec\prec y$ if and only if $g(x) \leq g(y)$.

3.2.4. Fuzzy model. In this case, the execution time of the task j is a sampled real fuzzy number $t_j = ((t_{j1}, p_{j1}), ..., (t_{jk}, p_{jk}))$, $j = 1, 2, ..., n$. Consider that $W = \{W_1, ..., W_m\}$ is a partition of V satisfying (1),...,(3). Condition (4) becomes

$$T(W_i) = \sum_{j \in W_i} t_j \quad \text{and} \quad \mathrm{Conf}(T(W_i) \leq C) \geq p_0, \; i = 1, ..., m. \tag{8}$$

Note that: $I_T(W)$ defined in **§2** is a fuzzy number now. Minimising this time has no sense. Instead of this time we take $g(I_T(W)) = mC - \overline{T}_{\mathrm{op}}$, where

$$\overline{T}_{\mathrm{op}} = g\left(\sum_{j=1}^{n} t_j\right) \tag{9}$$

is to be minimised. The defuzzified balance efficiency is

$$g(E(W)) = \overline{E}(W) = \frac{\overline{T}_{\mathrm{op}}}{mC}. \tag{10}$$

Clearly, the objective remains the same, i.e. determining a partition of V satisfying (1),...,(3) and (8) (a solution) with a minimal number of work stations, i.e. which minimises (9) or (10) (an optimal one). We note that the cycle time C should be regarded as a *target* or *desired* cycle time. Let us denote by $\mathcal{S}_F$ the set of solutions to the fuzzy ALB problem. Clearly, if G is acyclic and $\mathrm{Conf}(t_i \leq C) \geq c_0$ for $i = 1, ..., n$, then $\mathcal{S}_F \neq \phi$.

4. Basic algorithm for fuzzy ALB problem. The main idea of the algorithm is to construct a solution $W = \{W_1, ..., W_m\}$ by assigning tasks in a serial manner so that W_{i+1} is created after W_i. The tasks are assigned to work stations by extracting them from a list $\mathcal{L}$ of assignable tasks. Initially, this list contains the tasks with no predecessor. Currently this list contains in addition those tasks whose direct predecessors have been assigned to some previous or to the current work stations. A sublist $\mathcal{L}_f$ of $\mathcal{L}$ is constructed by retaining only those tasks i for which $\text{Conf}(T + t_i \lesssim C) \geq p_0$, where T is the fuzzy execution time of the current work station, i.e. by selecting those tasks which fit into the current station. If $\mathcal{L}_f = \phi$, then a new work station is created with $T = ((0, 1), ..., (0, 1))$ and $\mathcal{L}_f$ is rebuilt. If $\mathcal{L}_f$ has more than one task, a selection rule is applied in order to assign one of them. Consider a fixed defuzzification formula d_l from $d_1, ..., d_5$ defined by (9),...,(13). For each candidate task j, one computes $d_l(t_j)$ and one assigns that task j^* for which $d_l(t_{j^*})$ reaches the maximum value. As soon as a task is assigned it is removed from $\mathcal{L}$ and its time is added to the time its work station. Also, this task could allow to its successors to become assignable. Such a successor becomes a new member of $\mathcal{L}$. The assignment process continues while $\mathcal{L} \neq \phi$. It is easy to prove that if G is acyclic, then $\mathcal{L}$ becomes empty after the assignment of all the tasks to work stations. The algorithm requires $O(n^2)$ computing time if the data structure described in [13] for topological sorting is used.

The critical parts of the algorithm above are the fuzzy addition, the evaluating the confidence measure and the computation of the deffuziers. These computation are done $O(n^2)$ times. A systolic [14] implementation of fuzzy addition is given in [15] [16] and [17], while a linear systolic array to compute the confidence measure is described in [10]. What is necessary is a simple systolic architecture able to execute all the three critical operations. These operations are critical since they are required many times rather than for their intrinsic complexity.

5. Post-processing techniques for solution improving. This section describes two ways to improve an already solution to ALB problem with fuzzy execution times. To do this, suppose we have the solution $W = \{W_1, ..., W_m\}$.

The first way is to try to decrease the value of the cycle time while the value of the threshold is kept at the initial value. If this attempt is a successful one we can improve the overall performance of the line by preserving its structure. To do this, suppose that the processing times of the work station W_j is $T(W_j) = ((\tau_{j1}, \pi_{j1}), ..., (\tau_{jk}, \pi_{jk}))$ and compute $C' = \max_{j=1,...,m} \tau_{j,h_j^*}$, where $h_j^* = \max\{h | \tau_{jh} \leq C\}$. Clearly, it holds $C' \leq C$ and we can set C to C' without modifying the solution W.

The second way to improve the solution concerns the increase of the confidence threshold. If we compute $c_0' = \min_{j=1,...,m} \text{Conf}(T(W_j) \leq C)$, then $c_0' \geq c_0$ and we can use c_0' as the new value for the confidence threshold.

6. Other variants. In this section we discuss the possibility to extend the above presented results to more complicated but realistic variants of the ALB problem with fuzzy execution times.

6.1. Mixed models. In this case many models of the same produ̇ct are to be parallel assembled along the same line. Each model has its own precedence constraints and has a prescribed number of samples to be assembled. The same task could belong to more that one model with different processing in different models. The restrictions of the problem are similar to those of the single model ALB problem. In addition, it is required that each task must be entirely accomplished for all the models and all the samples in successive work stations. In [18] a reducing technique for solving the mixed models ALB with fuzzy processing time is presented. Other algorithms could be obtained by combining the above presented algorithm with the so called partial/total aggregating technique [19] In this case, the condition that the cycle time exceeds (in crisp or fuzzy sense) each processing time could be violated. The remedy is to split such a partial/total aggregated task into small enough pieces or to consider parallel work stations.

6.2. Parallel work stations. The main reason to use parallel work stations is the handling of the tasks whose execution times exceed the cycle time or the need to shorten the response time of the assembly line. In such cases the processing time of the parallel work stations are multiples of the cycle time. The algorithm presented in §4 can be easy modified in order to handle with different cycle times from one station to another one.

6.3. Compatibility with a task set cover. The challenge is to find a fuzzy way to treat an additional strong restriction related to the compatibility of each solution to a given cover of the set of tasks [19]. In this way we could create a u..tary framework for considering the skill levels, task separation and left/right sided tasks [20]. More precisely, if $R = \{R_1, ..., R_S\}$ is a cover of V, i.e. $R_1 \cup \cdots \cup R_S = V$, and $W = \{W_1, ..., W_m\}$ is an already obtained solution to ALB problem with fuzzy execution times, then we say that W is compatible to R if for each W_j there is at the least one $s \in \{1, ..., S\}$ so that $W_j \subseteq R_S$. It is not difficult to incorporate new rules in the above algorithm acting to do this, but it should of great interest to relax in a fuzzy way this compatibility condition.

7. Conclusions. We presented the fuzzy model of the assembly line balancing problem and proposed a low complexity heuristic for solving it and two post-processing techniques for improving the solutions. We also described other variants of the problem and shown how to adapt the proposed algorithm to solve them. The core algorithm was implemented in an interactive software dedicated assembly processes in clothing industry. The obtained results are more realistic and offer a higher flexibility in operation management.

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ECHILIBRAREA LINIILOR DE ASAMBLARE: MODELARE FUZZY ŞI TEHNICI DE REZOLVARE

(Rezumat)

Este considerată problema echilibrării liniilor de asamblare în care timpii de execuţie ai fazelor sunt numere fuzzy eşantionate. Sunt redefinite în mod fuzzy restricţiile principale şi funcţia obiec-

tiv şi este descris un algoritm de bază obţinut dintr-o abordare „greedy". Este descris modul de extindere a modelului matematic la cazul modelelor mixte şi al includerii de staţii paralele pe linia de asamblare şi sunt formulate probleme deschise.

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CONTRIBUTIONS À L'ÉLABORATION DES NORMES DE TRAVAIL SUR DE BASES SCIENTIFIQUES DANS L'INDUSTRIE DE CONFECTIONS

PAR
AURICA PÎCĂ

On présente les modalités de calcul du temps de base, élément structural essentiel de la norme de temps, qui correspond aux opérations technologiques du processus pour la confection des articles d'habillement.

Une de vois par laquelle on réalise l'accroissement de la production en fonction de l'augmentation de la productivité du travail est le perfectionnement permanent des normes de travail, sur de bases scientifiques, afin qu'elle se expriment rigoreusement la quantité réelle de travail nécessaire pour effectuer les travaux.

Dans l'industrie de confections textiles, les normes de travail, pour la plupart, n'ont pas de motivation technique; elles sont souvent déformées par des corrections avec des coefficients qui doivent assurer un certain dépassement de celles-ci.

Dans la branche de confections textiles, où les processus technologiques se trouvent en pleine action de standardisation, on a créé les conditions nécessaires pour élaborer et appliquer les normes unifiées sur des bases scientifiques.

La litterature de spécialité [1],...,[3] présente la méthodologie générale d'élaboration des normes de travail unifiées. L'application de cette méthodologie aux normes de travail dans l'industrie de confections présente une série de particularités dues à un ensemble de facteurs spécifiques, comme par exemple: type de production, forme d'organisation de la production et du travail, particularités de chaque opération technologique, caractéristiques des produits et des matières premières ainsi que des matériaux utilisés, etc.

Tout cela a rendu nécessaire l'analyse de chaque élément structural de la norme, l'identification des facteurs spécifiques d'influence pour chaque opération technologique, l'établissement des possibilités de calcul ou de mesure et le mode d'expression.

Dans ce travail, nous présentons les modalités de calcul du temps de base (t_b), élément structural essentiel de la norme de temps, qui correspond aux opérations technologiques principales dans la confection des articles d'habillement (Tableau 1) [4].

Pour les éléments de temps dépendant de facteurs spécifiques d'influence des opérations technologiques pris en considération, on va élaborer des normes de temps unifiées.

Tableau 1

Relations de calcul pour le temps de base dans le processus de confection de produits

Opération technologique	Relation de calcul	Explicité des symboles	*
1	2	3	4
Jaugeage	$t_b = Ll(t_{si} + l_{lc}t_c), [\frac{\text{min.}}{\text{encadr.}}]$ $l_{lc} = \sum n_{ri}p_{ri}/(Ll), [\frac{\text{min.}}{\text{m}^2}]$	L – longueur de la feuille de tissu, [m]; l – largeur de la feuille de tissu, [m]; t_{si} – temps spécifique d'encadrement jauges,[min/m^2]; l_{lc} – longueur spécifique de ligne de contour par 1 m^2,[m/m^2]; n_{ri} – no.de repères i avec le même contour d'encadrement; p_{ri} – périmètre d'un repère i, [m]; t_c – temps pour tracer le contour, [min./m].	t_i p_{ri} t_c
Stratification des feuilles de tissu	$t_b = nLt_1, [\frac{\text{min.}}{\text{feuille}}]$	n – no.feuilles de tissu; L – longueur de la feuille, [m]; t_1 – temps pour déposer 1 m tissu, [min./m].	n t_1
Sectionnement	$t_b = n_s t_{sc} lk, [\frac{\text{min.}}{\text{feuille}}]$ $k = l'/l$	n_s – no.sections; t_{sc} – temps sectionnement de la feuille on ligne droite, [min./m]; l – largeur de la feuille , [m]; k – coefficient complexité de la ligne de sectionnement (*1-1,3*); l' – longueur de la ligne de sectionnement, [m].	t_{sc} k
Découpage	$t_b = Llt_{dc}l_s, [\frac{\text{min.}}{\text{m}}]$ $l_s = \sum n_{ri}p_{ri}/c_{sm}$	L – longueur de la feuille de tissu, [m]; l – largeur de la feuille de tissu, [m]; t_{dc} – temps découpage 1 m de contour, [min./m]; l_s – longueur spécifique de la ligne de découpage, [m/m^2]; c_{sm} – consommation spécifique moyenne du produit, [m^2].	t_{dc}
Numérotage	$t_b = Nn_r n_p t_n, [\frac{\text{min.}}{\text{feuille}}]$	N – no.moyen feuille stratifiées; n_r – no.repères du produit; n_p – no.produits par 1 encadrement; t_n – temps numérotage d'un repère [min./repère].	t_n

Tableau 1
(continuation)

1	2	3	4
Thermocollage	$t_b = nt_{pc}$, $\left[\frac{\text{min.}}{\text{rep.}}\right]$ $t_b = St_{tr}$, $\left[\frac{\text{min.}}{\text{rep.}}\right]$ $t_b = (t_{pr} + t_r)/n$, $\left[\frac{\text{min.}}{\text{rep.}}\right]$	n – no.points nécessaire pour thermocollage; t_{pc} – durée d'un marquage par points avec fer à coller,[min./point]; S – surface de thermocollage, [m^2]; t_{tr} – durée du thermocollage avec le fer à repasser, [min/m^2]; t_{pr} – temps pressage avec presse de thermocollage, [min./repère]; t_r – temps de refroidissement, [min.]; n – no.repères par surface de thermocollage de la presse.	t_{pc} t_{tr} t_{pr}
Couture	$t_b = Lt_c$, $\left[\frac{\text{min.}}{\text{pièce}}\right]$	L – longueur de la couture, [cm]; t_c – temps couture par 1 bouton, [min./pièce].	t_c
Couture boutons	$t_b = nt_1$, $\left[\frac{\text{min.}}{\text{produit}}\right]$	n – no.boutons par produit; t_1 – temps couture par 1 bouton, [min./pièce].	t_1
Couture boutonnières	$t_b = nt_1$, $\left[\frac{\text{min.}}{\text{produit}}\right]$	n – no.boutonnières par produit; t_1 – temps d'exécution d'une boutonnière, [min./pièce].	t_1
Exécution orifices pour boutons-pression métalliques	$t_b = nt_0$, $\left[\frac{\text{min.}}{\text{produit}}\right]$ (2 éléments) $t_b = n(2t_0)$, $\left[\frac{\text{min.}}{\text{produit}}\right]$ (4 éléments)	n – no.orifices pour boutons-pression métalliques par produit; t_0 – temps pour exécuter 1 orifice, [min./orifice].	t_0
Montage boutons-pression métalliques	$t_b = nt_m$, $\left[\frac{\text{min.}}{\text{produit}}\right]$ (2 éléments) $t_b = n(t_{mp} + t_{mn})$, $\left[\frac{\text{min.}}{\text{produit}}\right]$ (4éléments)	n – no.boutons-pression par pression; t_{mp} – temps montage élément positif, [min./bouton-pression]; t_{mn} – temps montage éléments négatif, [min./bouton-pression].	t_{mp} t_{mn}
Repassage, pressage des bords, préformage, lissage	$t_b = St_c$, $\left[\frac{\text{min.}}{\text{pièce}}\right]$ $t_b = t_{pr}$, $\left[\frac{\text{min.}}{\text{pièce}}\right]$	S – surface du repère, élément de produit, [m^2]; t_c – temps repassage avec le fer à repasser, [min/m^2]; t_{pr} – temps repassage avec la presse à repasser, [min./pièce].	t_c t_{pr}

L'unification des normes de travail conduit à des effets économiques significatifs, tels que élimination des études et des mesures de temps qui amène à léconomie du temps consacré à l'élaboration des normes, élargissement de la sphère d'application de normes, extension et généralisation des plus avancés procédés de travail, possibilité de faire des comparisons entre les résultats des entreprises, confiance plus grande des exécutants en les normes établies, etc., effets qui contribuent à l'accroissement considérable de la productivité du travail, objectif prioritaire de l'industrie à l'heure actuelle.

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CONTRIBUŢII LA FUNDAMENTAREA ŞTIINŢIFICĂ A NORMELOR DE MUNCĂ ÎN INDUSTRIA DE CONFECŢII

(Rezumat)

Se prezintă modalităţile de calcul al timpului de bază, element structural al normei de timp, corespunzător operaţiilor tehnologice din procesul tehnologic pentru confecţionarea produselor de îmbrăcăminte.

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A DIAGNOSIS MODEL FOR QUALITY ASSURANCE IN ROMANIAN TECHNICAL UNIVERSITIES

BY

CARMEN-AIDA HUŢU, SILVIA AVĂSILCĂI, I. VERZEA and ILIE BULACOVSCHI

The core concept of the paper is centered on diagnosis as the critical factor which provides clarification and understanding, and must come before any other intervention targeting conscious, planned change for improving organizational performances.

The authors used the cybernetic system as the foundation for an organizational diagnosis model which is intended to offer a general frame of reference and wide flexibility necessary for adaptation to different contexts and situations. The elements/subsystems and configuration of the cybernetic system were translated into organizational concepts allowing to be adapted to different levels and layers of analysis.

The quality assurance diagnosis model, as an application of the proposed diagnosis model, emphasizes the specific issues concerning the qualitative aspects of the organizational life in the Romanian technical universities, offering: a comprehensive frame of reference which fits the quality assurance development needs of the Romanian technical universities; the possibility to be adapted to different levels of analysis and to different levels of complexity; the possibility to stress the environmental aspects and to focus the analysis into the domain of fits and gaps between various aspects of the system; the opportunity to remain open for future developments.

1. Introduction. Organizations, very much like people who created them, are distinct, unique entities. They have a life to live, they grow, mature and eventually become something else, they struggle with external forces in order to survive and preserve their identity.

And all this trip through life, equally for living beings and organizations, has only one certain aspect: permanent change.

Because organizations are so different, it is obvious that change occur differently for each of them. Some could change too quick or too slow, some could perform spectacular, successful changes, or some could die in the process. Some consciously plan and implement changes in order to fit needs, take advantage of opportunities and/or avoid threats, some resist while, unconsciously, some kind of transformations occur.

Also, change is always connected with fear, uncertainty, loss of control, confusion, resistance and pain even when led by the best ideas and intentions because change threatens the balance, the stability of the organization with tremendous impact on every single subsystem and element included. We cannot consider changing parts of the organization without actually transforming the whole system because everything

interacts and it is interconnected with everything else. Furthermore, each organization has its own "chemistry" and specific reactions to the environmental forces that must be determined and thoroughly understood in order to achieve effectiveness and success (even effectiveness and success must be well defined to clarify directions and means to reach them).

Maybe, more than anything else, diagnosis is the critical factor which provides clarification and understanding, and must come before any other intervention targeting conscious, planned change for improving organizational efficiency and effectiveness. Also, in order to offer valid, useful data for further approaches, diagnosis must be based on a comprehensive conceptual model which fits as accurately as possible the needs of the specific situation under investigation.

Although the literature offers a large range of organizational diagnosis models, we believe that every diagnosis situation requires a different frame of reference at least because of:

- the unique characteristics of the organization (degree of complexity, people, systems, processes, etc.);
- the specific context at the moment the diagnosis is performed;
- the purpose of diagnosis;
- the personal characteristics and preferences of the individual(s) performing the diagnosis.

2. The Conceptual Foundation for the Diagnosis Model. The authors' approach of understanding the world is based on a systemic frame of reference: an open system integrating interconnected natural and artificial subsystems and elements. Furthermore, it is well known (from the theory of systems) that the most common type of system in our world is the cybernetic system. As our assumption is that the artificial systems are created mostly after the living models, we believe that organizations are not exceptions. Therefore, we will use the cybernetic system as the foundation for an organizational diagnosis model which is intended to offer a general frame of reference and wide flexibility necessary for adaptation to different contexts and situations.

The cybernetic system is an open system interacting with its environment. Its main trait is transfer of information (besides transfer of various material elements). There are multidimensional interdependencies between outputs and inputs through the process(es) of transformation. The system has a final target (usually homeostasis – the preservation of its identity and dynamic equilibrium), and, through its most specific characteristic, feedback, compares the outputs with the target and transmits information to inputs and processes to execute outputs with characteristics which are the closest possible to those of the target. We think that this model is boldly looking alike a real organization.

In our opinion, the existence of the final target as a base for comparisons offers the possibility for designing a simple and flexible diagnosis model, taking into account not only the current state of the system, but also the desired outcomes, and ultimately facilitating the identification of the appropriate interventions.

3. The Diagnosis Model – A Theoretical Framework. The diagnosis model proposed in Fig. 1 allows the use of different parts of other models, flexibly, where and when it is appropiate.

We followed the elements/subsystems and configuration of the cybernetic system, translating the general concepts into organizational ones. For instance, vision, mission and goals replace the final target of the cybernetic system, giving a direction and purpose to the system in correlation to the requirements of the environment (external and internal). The regulatory signal is materialized through management, leadership and the core elements of the culture like basic assumptions, beliefs and the value system.

For strategy, we adopted the place assigned by N a d l e r and T u s h m a n [1] because any efficient and effective transformation process couldn't occur without a strategic attempt, which means correlating this process with the available resources (both ways) based on an "environment sensitive" direction and purpose given by vision, mission and the core values of the system.

Also, the model is flexible enough to be adapted to different levels of analysis, keeping in mind that one of the properties of the cybernetic system (as an open system) is inclusion, meaning that it contains subsystems which are cybernetic systems and can be integrated into larger cybernetic systems.

The only common trait for all of analysis is the transfer of information through different forms of communication. Everything else can be defined accordingly to the intended diagnosis level (i.e., organizational; group/unit; individual). For instance, at the individual level (which seems to be the most sensitive approach), the categories of the model could be detailed as the following:

⋆ environment:

– task: the characteristics of the physical setting (configuration, treatment of space, noise, vibrations, light, etc.); technology and equipment used, etc.;

– general: the economic and legal system, the state of technology in the specific field considered; family characteristics; the individual's cultural background, etc.;

⋆ inputs:

– organizational and group design and processes [2];

– personal profile: physical, psychological, social, education/training, attitudes, norms, assumptions, needs, etc.;

– information;

⋆ strategy: broad direction based on personal vision, mission and goals (as means for successful survival and adaptation to the environmental requirements), and driven by personal core values through self-management and support from direct management and leadership (feedback);

⋆ the transformation process:

– individual objectives and plans (as "organizers" for the processes);

– individual's place in the formal/informal structure;

– personality structure/type directly shaping the processes (i.e., Myers–Briggs, neurotic type, accented personalities, etc.);

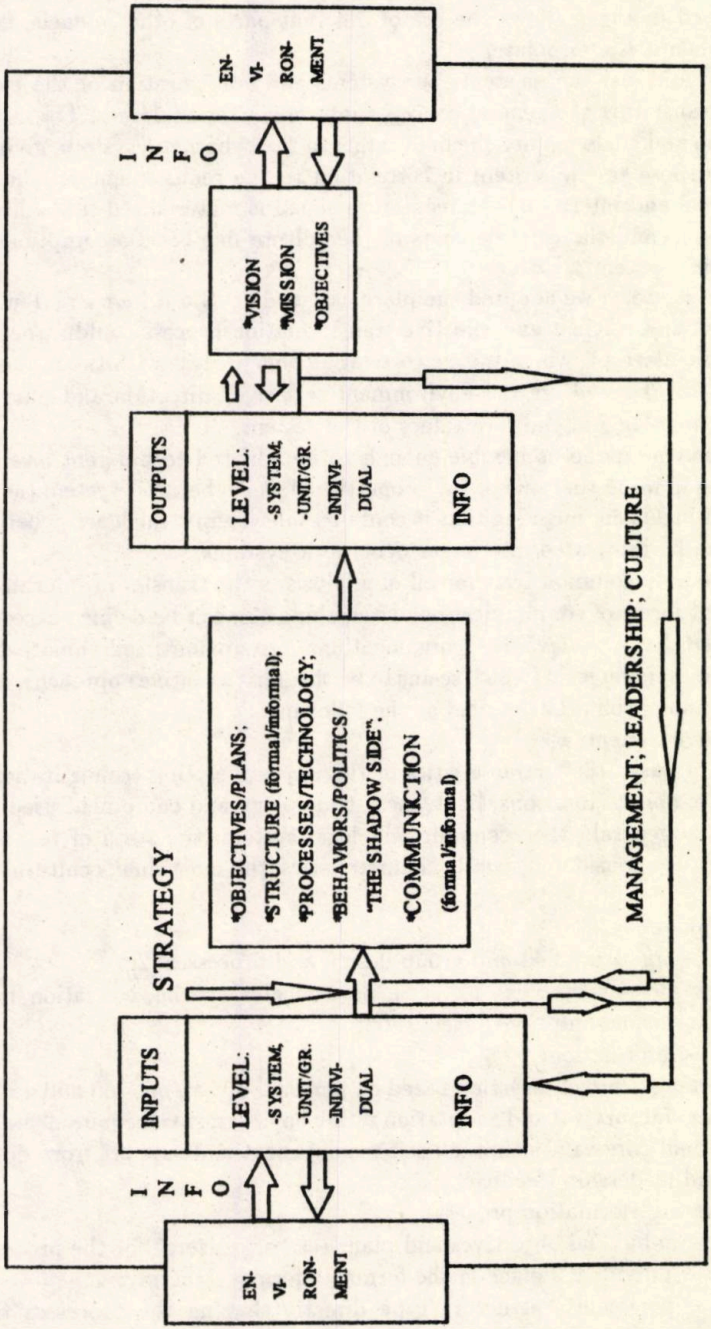

Fig. 1.– Diagnosis framework based on the system model.

– processes/technology (task characteristics [3]): task identity and significance: skill variety; autonomy; feedback regarding job performance; ergonomics, etc.;

– behaviours/politics (individual orientations): motivation; commitment; involvement; rewards experienced; specific attitudes and behaviours; personal norms; power and influence; political games; leadership style (if appropiate), etc.;

– communication: formal/informal + individual characteristics (oral, written, body language in terms of frequency, styles, etc.);

⋆ outputs (to be compared with vision, mission, goals):

– performance; job satisfaction; personal development; absenteeism, etc.;

– information;

⋆ vision, mission, goals:

– personal approach: check of fit with vision, mission and goals of the larger system.

It can be easily seen that not only gives the model the opportunity to identify various gaps between the current and the "ideal" state of the system at the level where the diagnosis is performed, but it also allows identifying gaps/fits with other levels of the organization and the environment.

To take another example, if one needs to perform the diagnosis at the organizational level, one can use (entirely or partially) the subtask models in E g a n Model *A* [4] and Model *C*. Also, Model *B* can be used to assess fits and gaps between the current and the desired state of the organization and to determine appropiate interventions for change because most of the broad categories used by E g a n have correspondents in our model (but following a different logical interconnection).

4. The Diagnosis Model – A Quality Assurance Approach. The quality assurance diagnosis model (Fig. 2) emphasizes the specific issues concerning the qualitative aspects of the organizational life in the technical universities, considering the specific Romanian background.

The final target is represented by the main outcomes: competitive position and the image of the university, giving a direction and purpose to the system. The regulatory signal is materialized through quality management, leadership and the core elements of the culture sustaining the quality approach.

The strategy must correlate the processes with the inputs based on an "environment quality sensitive" direction and purpose given by the proposed outcomes of the system.

The different levels taken into account for quality assessment are: university (the whole system); faculty; department; individual. The levels must be related by the transfer of information and data through the quality assurance processes. All the levels will be examined accordingly to the intended diagnosis purpose, which is the assessment of the university's quality assurance approach.

Considering the same example mentioned above, at the individual level, the categories of the model related to the quality assurance approach could be:

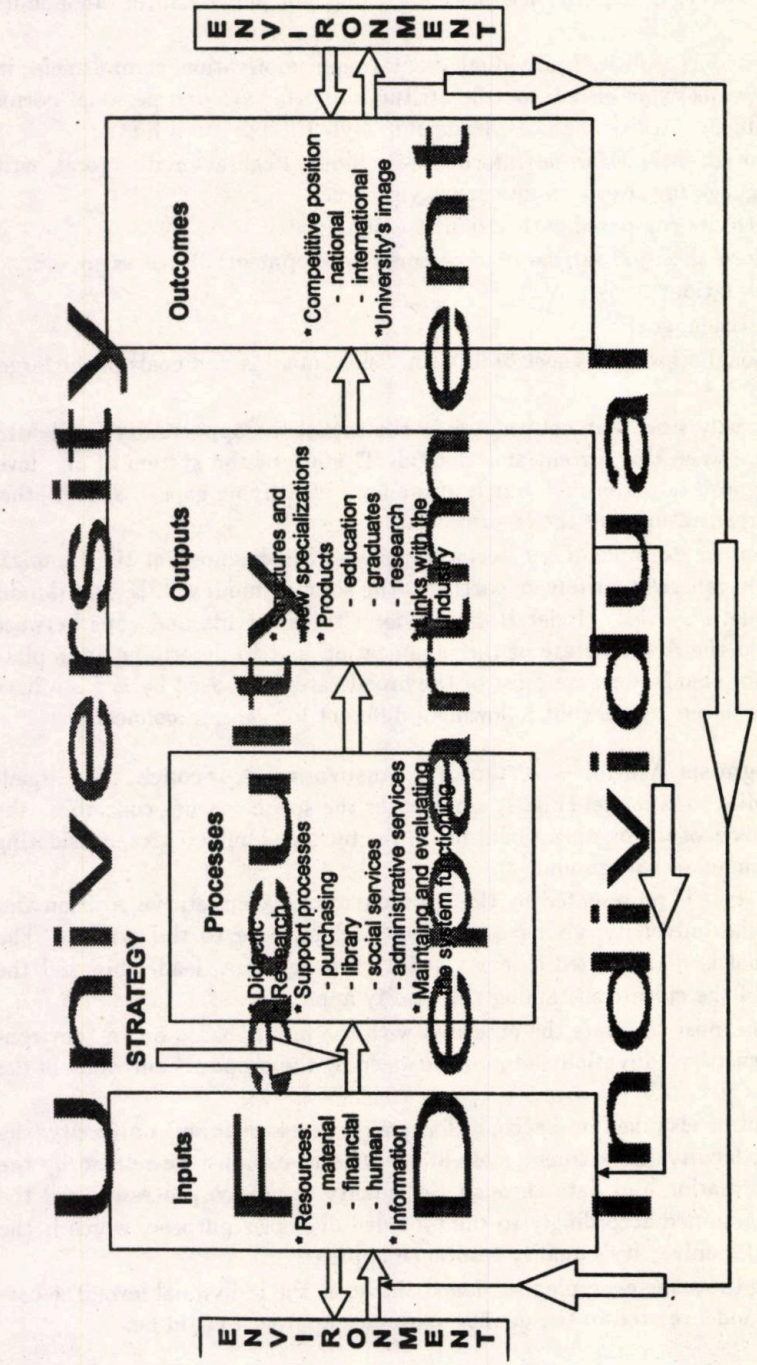

Fig. 2.– A quality assurance diagnosis model.

⋆ environment:

– task: the characteristics of the physical setting (classroom treatment of space, office space, noise, light, etc.); technology and equipment used for the teaching and research processes, etc.

– general: the internal structure of the department/faculty/university; the stage of development of the higher education system in Romania; the legal systeml the state of technology used in the teaching and research processes; family characteristics; the individual's professional and cultural background, etc.

⋆ inputs:

– department/faculty/university educational processes;

– resources (financial and material);

– information;

– personal profile: physical, psychological, social, education/training, attitudes, norms, assumptions, needs, etc.

⋆ strategy: personal vision, mission and goals related to the personal quality assurance of the professional activity (educational and research);

⋆ the transformation process:

– individual objectives and plans defining the personal quality assurance approach;

– individual's role in the formal/informal structure;

– personality structure;

– task characteristics: task identity and significance related to quality assurance approaches; automony of the teaching and research processes; feedback regarding the teaching and research performance, etc.;

– individual orientations: motivation for quality approaches; commitment; involvement; rewards experienced for implementing quality assurance processes; specific attitudes and behaviours related to quality approaches; personal norms involving quality standards; the use of power and influence for the implementation and use of quality systems for teaching and research, etc.

– communication: formal/informal; the role of the individual communication style to the quality of the communication processes;

⋆ outputs (to be compared with the outcomes):

– performance in correlation with quality assurance of the teaching and research processes; personal satisfaction and development, etc.;

– information;

⋆ outcomes:

– personal approach: check of fit with competitive position and image of the department/faculty/university.

5. Conclusions

1° The model offers a comprehensive frame of reference which fits the quality assurance development needs of the Romanian technical universities.

2° It makes the diagnosis process less overwhelming, allowing the possibility to be adapted to different levels of analysis and to different levels of complexity.

3° It stresses the environmental aspects which are so important in relation to change.

4° It "forces" the analysis into the domain of fits and gaps between various aspects of the system (i.e., relationships between the system and the environment; correlation – via information/communication – among various subsystems and between subsystems and the whole organization; gaps/fits between the current state and the desired one of the system/subsystems at different levels, etc.).

5° The model remains open for future developments.

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MODEL DE DIAGNOZĂ PENTRU ASIGURAREA CALITĂŢII ÎN UNIVERSITĂŢILE TEHNICE ROMÂNEŞTI

(Rezumat)

Conceptul cheie al lucrării este diagnoza, considerată drept factor critic al oricărei intervenţii ce intenţionează schimbarea conştientă, planificată în vederea îmbunătăţirii performanţelor organizaţiilor.

Autorii au utilizat conceptul de sistem cibernetic ca fundament pentru un model de diagnoză a organizaţiilor, intenţionând să ofere o bază de referinţă pentru adaptarea la diferite contexte şi situaţii. Elementele/subsistemele şi configuraţia sistemului cibernetic au fost transpuse conceptelor organizaţionale, permiţând utilizarea modelului pe diferite niveluri de analiză.

Modelul de diagnoză pentru determinarea gradului de asigurare a calităţii, ca aplicaţie a modelului general propus, evidenţiază aspectele calitative ale vieţii organizaţionale în universităţile tehnice româneşti, oferind: un sistem de referinţă comprehensiv, în concordanţă cu nevoile de dezvoltare a învăţământului superior tehnic; posibilitatea de adaptare pe diferite niveluri de analiză şi diferite niveluri de complexitate; posibilitatea de evidenţiere a aspectelor contextuale şi de focalizare a analizei pe domeniile de concordanţă şi neconcordanţă a diferitelor elemente ale sistemului cu standardele de calitate impuse; oportunitatea de a rămâne deschis pentru dezvoltări viitoare.

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RECENZII

BOOK REVIEWS

. * . *Maschinen und Geräte im Bekleidungsbetrieb.* VEB Fachbuchverlag, Leipzig, 1989, 180 S., ISBN 3-343-00267-4.

Für die Werktätigen der Bekleidungsindustrie und des Bekleidungshandwerks besteht die gemeinsame Aufgabe, den ständing wachsenden Bedürfnissen der Bevölkerung nach hochwertiger und modisch aktueller Bekleidung immer besser durch den Einsatz effektiver Fertigungstechnologien und moderner Maschinen sowie Gerätetechnik gerecht zu werden.

Bei der Herstellung der konfektionierten und der handwerklich gefertigten Kleidung muss verstärkt darauf Einfluss genommen werden, durch die zielgerichtete Anwendung des wissenschaftlich-technischen Fortschrits die Produktivität zu erhöhen und die Verarbeitungsqualität der Erzeugnisse weiter zu verbessern. In der Bekleidungsindustrie und im Bekleidungshandwerk sind die Prinzipien sozialistischer Rationalisierung konsequent anzuwenden. Der Automatisierungsgrad in der Kleidungsfertigung beträgt gegenwärtig knapp 10%, der Grad der Mechanisierung etwa 70%, bei zahlreichen mechanisierten Arbeitspläzen sind aber nach wie vor noch manuelle Arbeitsoperationen zu verrichten. Eine wichtige Aufgabe der Ausbildung von Lehrlingen und Werktätigen zu Facharbeitern besteht darin, den Kleidungsfacharbeitern, Facharbaitern für Näherzeugnisse, Damenmassschneidern und Herrenmassschneidern eine solide maschinentechnische Grundlage für die Ausübung ihres Berufes zu vermitteln, die dazu beiträgt, ihnen eine breite Einsatzmöglichkeit in ihrem Beruf zu sichern. Dabei kann der Erwerb des beruflichen Wissens auf der Grundlage solider naturwissenschaftlicher Kenntnisse, die in der polytechnischen Oberschule erworben wurden, erfolgen.

Die Autoren dieses Lehrbuches liessen sich von dieser Zielstellung leiten. Die ausgewählten Lehrstoffe sind wesentliche Bestandteile des erforderlichen Wissens und Könnens beruflicher Grundlagenbildung einschliesslich der beruflichen Spezialisierung. Bei der Themenauswahl wurden der Lehrplaninhalt ebenso wie neue Entwicklungtendenzen der Maschinen- und Gerätetechnik berücksichtigt. Der Umfag der einzelnen Abschnitte ist massgeblich von den unterschiedlichen Anforderungen in industriellen und handwerklichen Bekleidungsberufen bestimmt. Gegenüber dem Lehrbuch „Maschinenkunde Kleidungsfacharbeiter" wurden insbesondere die Abschnitte „Spezialnähmaschinen" und „Nähteilautomaten" wesentlich erweitert und besser systematisiert. Der Abschnitt Maschinen und Geräte für Trennprozesse wird dem raschen Strukturwandel in den Fertigungsstufen Zuschnitt und Zuschnittvorbereitung stärker gerecht.

Die Autoren verzichteten bewusst auf das Erläutern aller technischen Details der ausgewählten Arbeitsmittel. Vielmehr soll dem Lernenden der notwendige Einblick in die Prinzipien und die Funktion typischer Elemente der Maschinen, Anlagen und Geräte ermöglicht werden. Zahlreiche Zeichnungen und Fotos unterstützen dieses Anliegen.

Die Wiederholungsfragen ermöglichen dem Nutzer dieses Lehrbuches das rasche Erkennen inhaltlicher Schwerpunkte, sie dienen zugleich als Anleitung beim systematischen Selbststudium und gestatten wirksame Leistungskontrollen.

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